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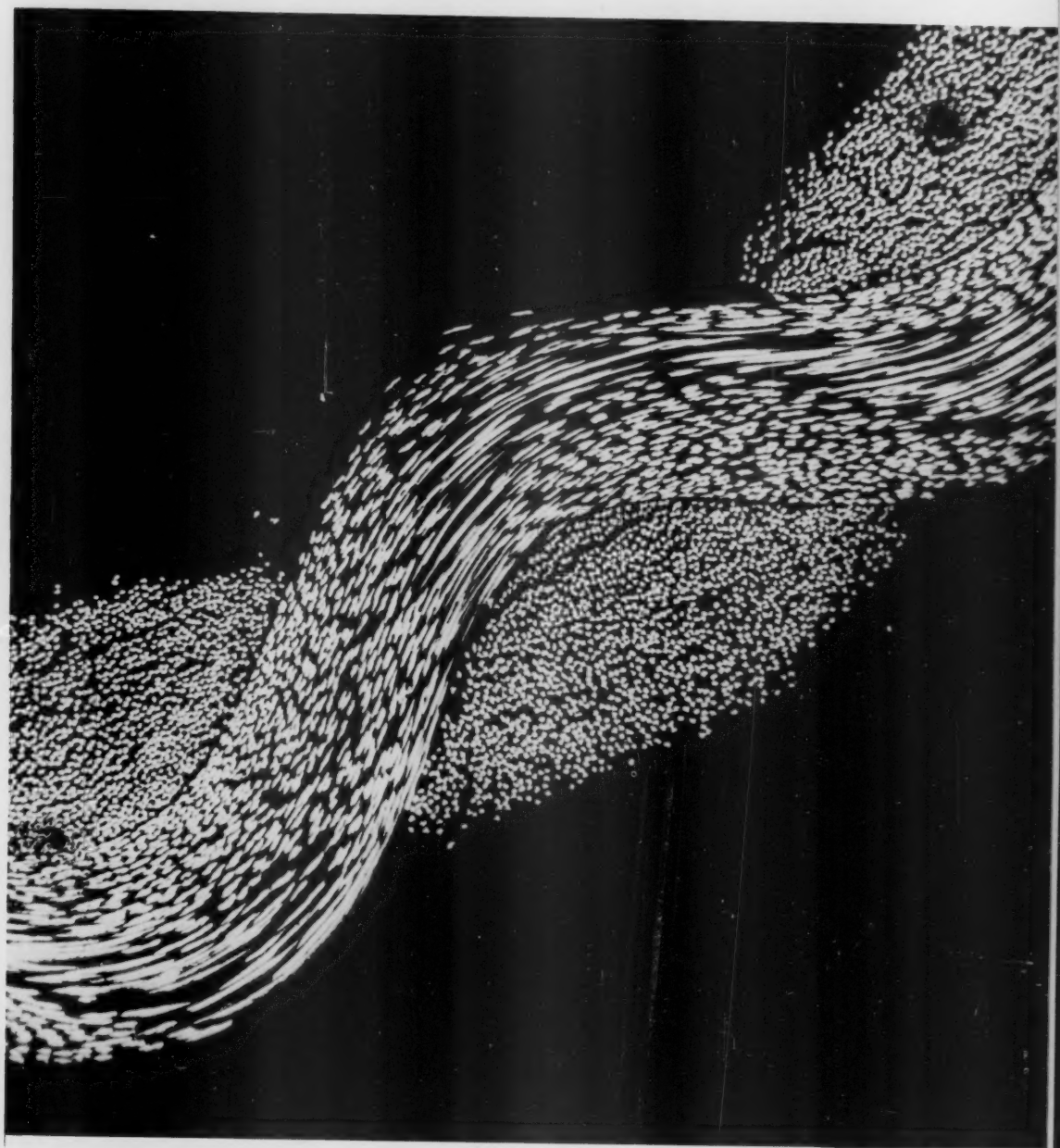
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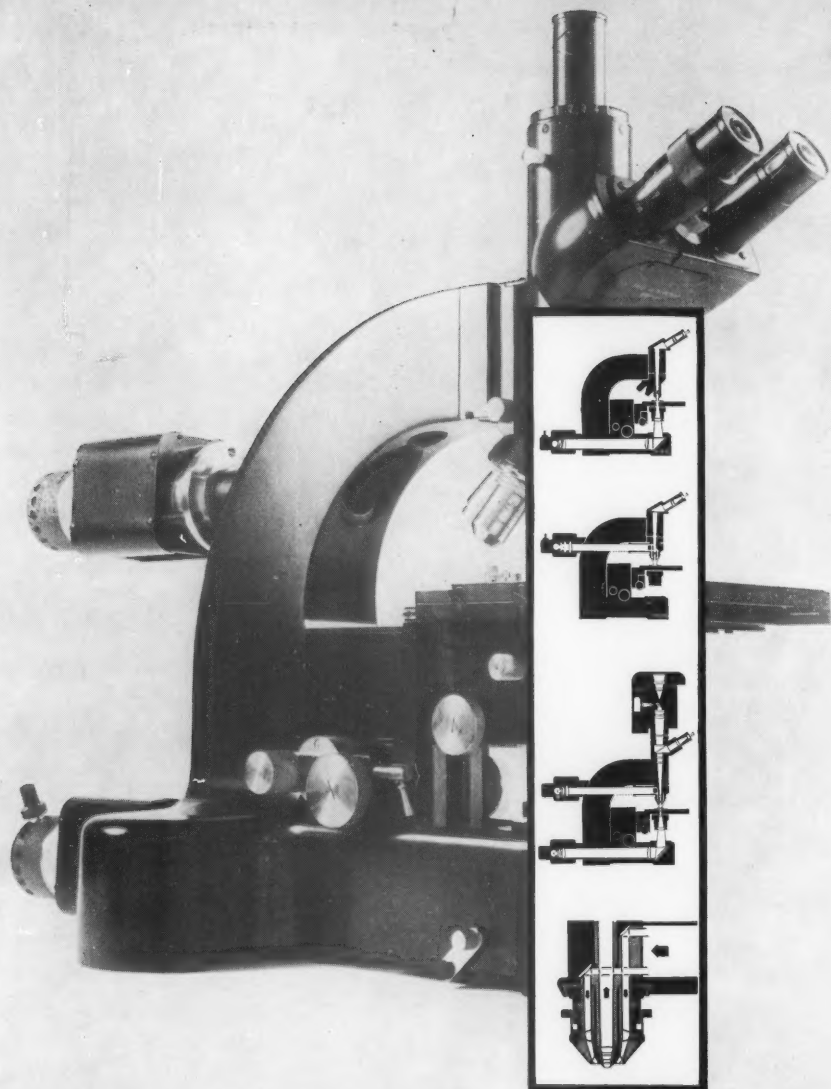
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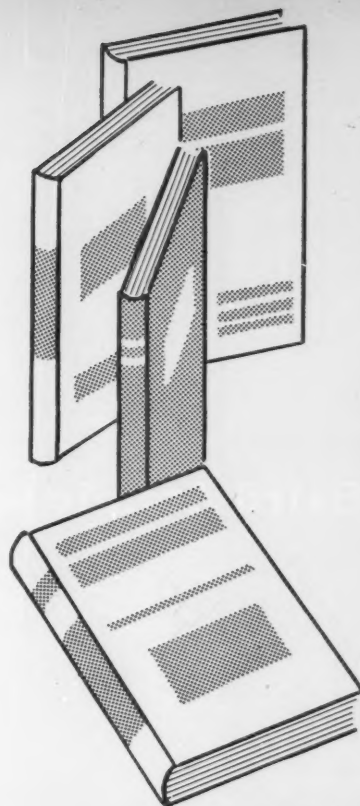
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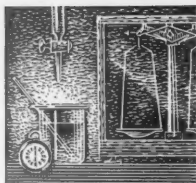
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Cover	Graphite cloth, single-ply plain weave, reinforced with clear plastic. Each yarn bundle contains 1440 graphite filaments. Fabrics or filaments are combined with plastic resins for molding of missile and rocket motor components. This specimen was prepared by slicing parallel to one direction of the cloth before examination under the microscope (about $\times 150$). [National Carbon Company]	

IT HAPPENED THIS MONTH...

a glance at yesterday in relation to today



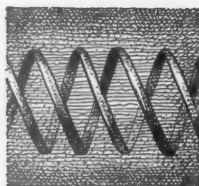
IN NOVEMBER — (1850) — *American Journal of Science and Arts* reports a talk by A. Voelcker in which he attempts to show that there is considerable inaccuracy in the usual estimation of the nutritive qualities of food (based upon determination of total nitrogen). The food under discussion is a fungus called *Agaricus pruness*, which is highly edible and remarkable for forming most beautiful fairy rings. Protein was separated by precipitation with basic acetate of lead, and nitrogen determined by combustion. Results indicate that less than 5 per cent of the nitrogen in the dry fungus exists as protein compounds and nearly one-third is ammonia or some other form without nutritive value.¹

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IN NOVEMBER — (1937) — Thannhauser and his co-workers² report some studies on the effects of thiol compounds on phosphatase activity of human serum. In a previous paper they had reported a marked activation of serum phosphatase by ascorbic acid. Now, cysteine and reduced glutathione are shown to produce a sharp decrease in phosphatase activity and to neutralize ascorbic acid activation. This deactivation occurs in serum taken from normal individuals and from patients with Paget's disease (a bone disorder characterized by high serum phosphatase levels). However, these impressive deactivating effects of cysteine cannot be reproduced *in vivo*.

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IN NOVEMBER — (1956) — the Watson-Crick structure of DNA is slightly modified. They had assumed that one of four pairs of complementary purines and pyrimidines (adenine-thymine, thymine-adenine, guanine-cytosine, and cytosine-guanine) is present at each level of two intertwining polynucleotide chains. Each pair was presumably linked by two hydrogen bonds. The model provides a postulate for the duplication of genes: the two polynucleotide chains could separate, and each might serve as a template for replication. Now, study of crystal structure data by Pauling and Corey indicates that adenine and guanine should be linked by three hydrogen bonds. This corresponds to a higher degree of specificity and therefore strengthens the Watson-Crick theory of gene duplication.³

If you are studying gene duplication or nucleic acid structure you will find a wide selection of nucleic acid precursors on the new Schwarz BioResearch list, including many labeled with C^{14} or H^3 . Send for our new catalog and price list.

1. Voelcker, A.: On the percentage of nitrogen as an index to the nutritive value of food. *Am. J. Sc.* 10:403 (Nov.) 1850.

2. Thannhauser, S. J.; Reichel, M.; Grattan, J. F., and Maddock, S. J.: Studies on serum phosphatase activity. IV. The deactivating effect of thiol compounds and bile salts on serum phosphatase activity *in vitro* and *in vivo*. *J. Biol. Chem.* 121:721 (Nov.) 1937.

3. Pauling, L. and Corey, R. B.: Specific hydrogen-bond formation between pyrimidines and purines in deoxyribonucleic acids. *Arch. Biochem.* 65:164 (Nov.) 1956.



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The Well-Rounded Man

"Musical, literary, artistic, but I should say normal—a very charming girl."

"Margaret's anger and terror increased every moment. How dare these men label her sister! What horrors lay ahead! What impertinences that shelter under the name of science!"

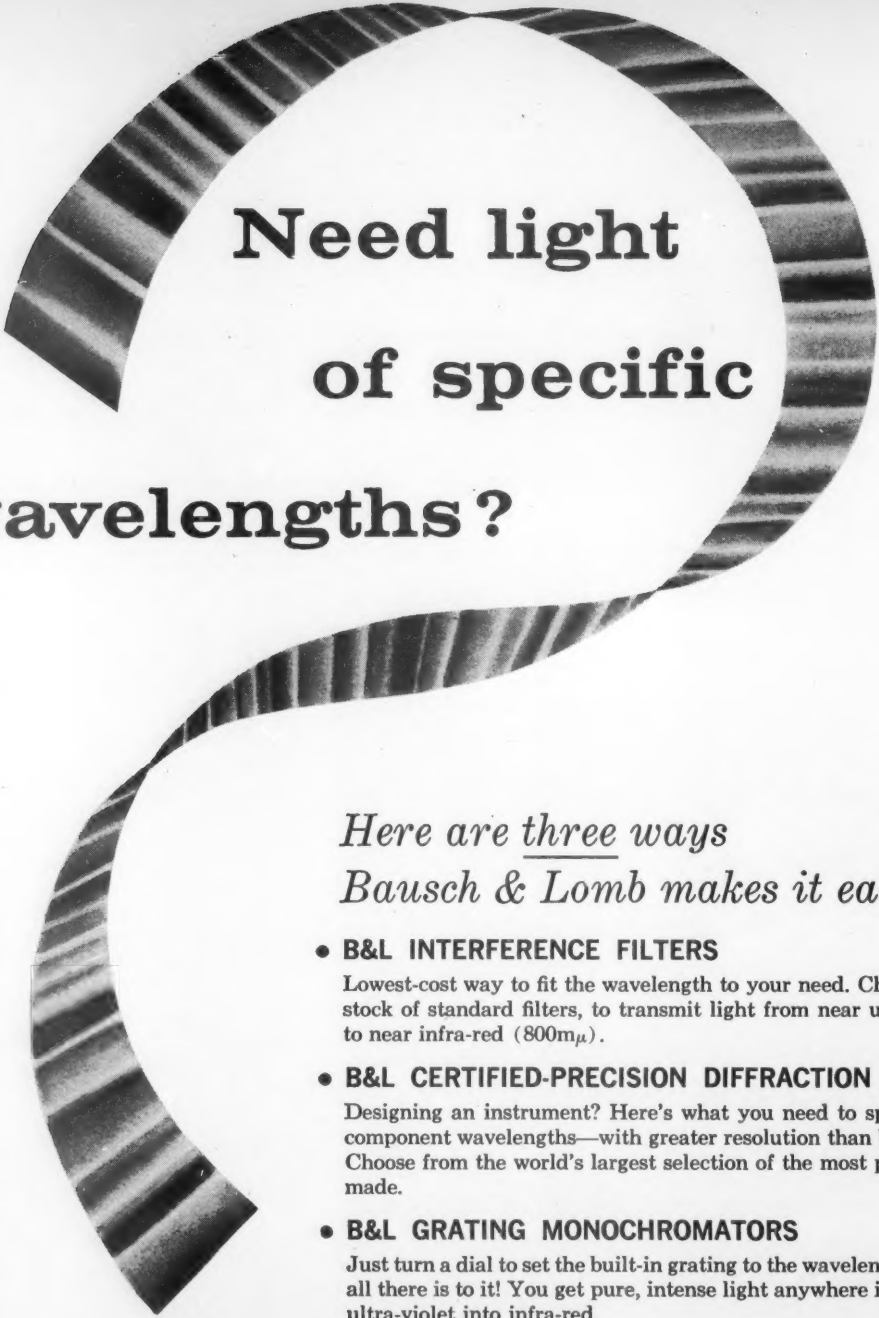
Thus does E. M. Forster, in his novel *Howard's End*, epitomize the differences between the scientific-medical and the romantic-humanistic appraisal of personality. And Sir Charles Snow, in his *The Two Cultures and the Scientific Revolution*, thus deplores the gulf between those educated in the humanistic and those educated in the scientific tradition: "Closing the gap between our cultures is a necessity in the most abstract intellectual sense, as well as in the most practical. When these two senses have grown apart, then no society is going to be able to think with wisdom."

The latest evidence that the gap exists is provided by the results of a test prepared by Kenneth Richmond of Glasgow University [*The Times Educational Supplement* (29 Sept. 1961)]. Each of more than 3000 people (students and professors) was asked 20 questions in the arts and 20 in the sciences. Here are some of the questions in the sciences: "The uncertainty principle was enunciated by (a) Gauss; (b) Heisenberg; (c) Tinbergen; (d) Lamarck; (e) T. H. Huxley; (f) none of these. A cloud chamber is used in (a) an artist's studio; (b) an oil refinery; (c) a physicist's laboratory; (d) a weather ship; (e) an actor's dressing room." And in the arts: "One of these is said to have a *Blue Period*—(a) Henry Moore; (b) Cezanne; (c) Utrillo; (d) Balzac; (e) Picasso; (f) Rembrandt; (g) none of these. With which of the following would you couple the name of Frank Lloyd Wright? (a) Erik von Stroheim; (b) Jan Van Eyck; (c) Mies van der Rohe; (d) Gerard Manley Hopkins; (e) Schrodinger; (f) none of these."

The following tentative conclusions emerge: the average performance is surprisingly low; those who do well in science are on the average more one-sided than those who do well in the arts; and few do well in both fields. The averages range from a low of 3.2 out of 20 in the arts and 3.7 in the sciences for students at a women's training college for teachers to a high of 7.3 in the arts and 10 in the sciences for "sixth-formers" (grammar school students) in a public (equivalent to our private) school. Graduate students in university teacher-training courses did a little less well than the sixth-formers: 6.8 in the arts and 9.3 in the sciences in one university; 7.4 in the arts and 8.6 in the sciences in another.

It is not clear whether the pattern of one-sidedness and the attitudes that accompany it are set so early that broader education could not correct the imbalance, and whether, indeed, Sir Charles and Mr. Richmond are asking the most important questions. Would all be well if education could fuse the two cultures into one, as Sir Charles seems to imply?

What is extraordinary about this test and about Sir Charles's book is the assumption that knowledge of the sciences and the arts is alone worth considering. As Lloyd Fallers points out in the *Bulletin of Atomic Scientists* (Oct. 1961), Sir Charles almost completely neglects a "third culture—that concerned with man in society." So does the test. Education that neglects to give some understanding of politics, of history, of anthropology, of economics, and of the parts that science and engineering play and should play in a modern state, will hardly suffice to give us wise administrators in government and industry—G.DuS.



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The Optical Spectrum of Lightning

A revival of the spectrographic study of lightning may help solve some outstanding puzzles in cloud physics.

Leon E. Salanave

Although a great deal of attention has been given to the mechanisms of charge generation and lightning, there still exists much uncertainty about the details. It is reasonable to expect that with improved observational techniques it should be possible to learn more about the nature of the processes involved. In this connection a detailed knowledge of the physical conditions surrounding the lightning discharge assumes considerable importance.

A large amount of work has been done on the long-wavelength (radio) region of the lightning discharge spectrum; this has obvious applications to communications and the detection of nuclear explosions, in both of which lightning produces interference. Also, much work has been done on the direct photography of lightning (especially with the Boys camera), to obtain time resolution.

Comparatively little use has been made of the optical spectrum. It has always been obvious, of course, that this spectrum must resemble that of the ordinary spark in air, but even here there are some interesting differences which require explanation. In this connection it should be noted that the

energy of the discharge is extremely large: Potential differences of the order of 1 billion volts produce pulsed currents of 50,000 amperes and more, each pulse lasting only a few milliseconds. It is common for a flash to consist of a dozen or more such pulses, or "strokes." It is not surprising, therefore, that the spectrum has some interesting features—shared by some of the plasma phenomena which are of such wide interest in contemporary physics.

During the summer of 1959 I was impressed by the brilliant, vertical flashes of lightning which occurred with almost clocklike regularity over the Santa Catalina Mountains in southwestern Arizona. It seemed evident that interesting spectra could be obtained by placing a prism or grating in front of an ordinary camera lens in such a way that the direction of dispersion was horizontal. This is merely an extension of the objective prism technique long used by astronomers in the study of meteors, comets, and sharp-emission nebulae.

The lightning flash has been an object of spectroscopic analysis for almost 100 years, but the literature is not extensive, and surprisingly little research seems to have been done in view of the great amount of information that can usually be expected from spectrum analysis of

an optical phenomenon. In a thorough search of the literature I found only 19 references to research done since 1900 that involved the photographic observation and interpretation of lightning spectra. In these investigations the equipment has generally been adapted from pre-existing instruments—usually fast, low dispersion slit spectrographs used by astronomers to study auroras, nebulae, and other faint sources. This equipment has enabled the observers to record the lightning spectrum by way of the general illumination on clouds but not in the stroke directly; it would be extremely unlikely that a lightning stroke could be imaged on the slit of a conventional spectrograph. This situation can be partially circumvented by using a *slitless* spectrograph, but even less use has been made of this instrument than of the other (1). The especially favorable characteristics of "blazed" diffraction gratings, which combine good illumination with high dispersion and resolution, open up wide possibilities in slitless spectroscopy.

Survey of Observations, 1901–1960

At the beginning of the century Pickering (2) at Harvard Observatory and Fox (3) at Chicago secured the first slitless spectra of lightning. In 1905 Larsen (4) published two spectra he obtained with a small prism in front of an ordinary hand camera. The first slit spectra were secured in 1917, when two spectrograms were obtained by V. M. Slipher (5) at the Lowell Observatory. The knowledge of spectra at that time was sufficient to provide some chemical identifications, but not to yield information on the physical processes involved.

From 1923 to 1925 J. Dufay (6) obtained 14 slit spectra covering the region from 2800 angstroms to H-alpha. Molecular bands attributed to N₂ were added to the list of atomic nitrogen and oxygen lines already known from the work of Slipher. At this time the quantum-mechanical

The author is affiliated with the Institute of Atmospheric Physics, University of Arizona, Tucson.

theory of spectra was just emerging. Energy-level diagrams, excitation potentials, and related tools of spectrum analysis were only newly developed and were not immediately applied to working out the energy levels in the lightning discharge.

In 1941, Israel and Wurm (7) obtained nine slitless spectograms, but only the best one was studied at that time. They classified the lines into multiplets, with corresponding excitation potentials, and hence were able to arrive at some notion of the energy involved in the discharge. The lines of N II, which are the most prominent features of slitless spectra, typically have upper excitation potentials around 20 electron volts, or 34.5 electron volts above the ground state of N I. As a result of their analysis, Israel and Wurm were the first to report that the degree of excitation increases from the cloud toward the

Table 1. Census of published observational material.

Classification	Spectra (N)
1) Slit spectra	
a. From the ultraviolet, through the visible, to H α (1917-60)	34
b. In the red and near infrared, as far as 9000 A (1950-52)	5
2) Slitless spectra	
a. Early observations (1901-05), before an adequate theory of spectra had been proposed	17
b. Later work (1941-49), subject to interpretation in terms of excitation along the discharge	7

ground. In a later publication (8) Israel and Wurm presented analyses of five spectra they had secured in 1941. The most interesting feature of this work seems to have been the discovery of emissions due to ionized calcium at the base of a stroke which hit the

ground about 2 kilometers from their camera.

In 1943 Nicolet (9) published a revision of Slipher's list of lines and classified them according to multiplets.

In 1947 and 1949, J. Dufay and M. Dufay, with T. Mao-Lin (10, 11) published what is, even today, the most comprehensive study of the lightning spectrum in the range from 2950 A to H-alpha. The region above 3838 A was studied on ten spectrograms; below this wavelength the analysis rested on a single spectrum. Also in 1949, the Dufays (12) published the results of studying an exceptionally good slitless spectrogram. It was obtained with a 60° prism in front of an F/4.5 lens of 8-centimeter aperture; the dispersion was 44 angstroms per millimeter at 4000 A. From photometer tracings of this spectrum, whose hydrogen lines were assumed to be broadened by the Stark effect, the intermolecular field was estimated to be of the order of 20,000 to 40,000 volts per centimeter, and the ratio of ionized to neutral particles was calculated to be 5×10^{-4} . The findings confirmed the observation of Israel and Wurm that the excitation increases toward the ground.

During the years from 1950 to 1952, fast slit spectrographs of low dispersion were used to extend observations into the near infrared as far as 9078 A. The work of Jose (13), Petrie and Small (14), and Knuckles and Swensson (15) produced a total of five spectrograms. Lines due to neutral argon were found by Petrie and Small.

In 1959, L. Wallace (16) obtained an excellent slit spectrogram in the region from 3670 to 4280 A, using an auroral grating spectrograph with a dispersion of 22 angstroms per millimeter. Most recently, Hu Ren-Chao (17) published a report on the study of seven split spectra taken with an auroral spectrograph. The instrument was provided with a grating and gave a dispersion of 100 A/mm over an interval of 1500 A. In a series of hour-long exposures Hu Ren-Chao and his associates covered the region from 6563 A (H α) to 2811 A, in which range they found 200 emission lines and band heads. This investigation also included a comparison between lightning and spark spectra.

A census of the published observational material is shown in Table 1. Note that the important information to be expected from studies under the classification 2b has been based upon a relatively small number of spectra.

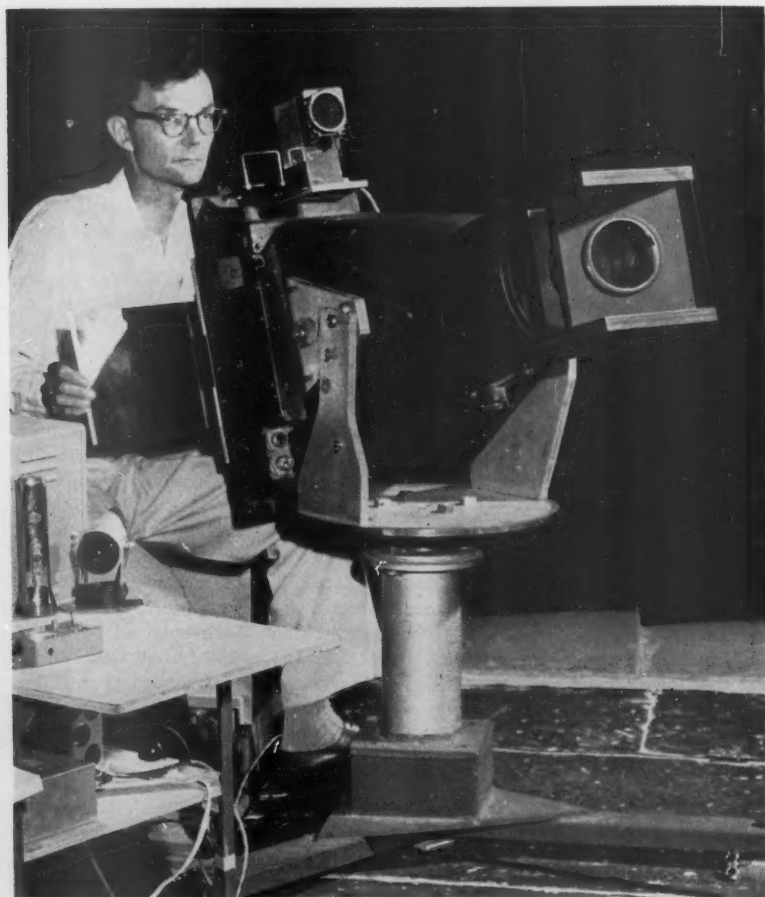


Fig. 1. Lightning spectrograph in use. The dark-slide is drawn from in front of the 8- by 10-inch film holder and then closed when a bright flash appears in the view finder. The prism-grating assembly is shown attached to the front of the K-18 aerial camera. [Bob Broder, University of Arizona Press Bureau]

Aerial Camera Fitted with Diffraction Grating

Under the joint sponsorship of the University of Arizona's Applied Research Laboratory and Institute of Atmospheric Physics, a number of good spectra were obtained in a pilot investigation during the summer of 1960.

The instrument consisted of a K-18 Aero-Tessar camera modified to use 8- by 10-inch Eastman Royal Pan cut film and equipped with an objective prism-grating combination (see Fig. 1). The prism and grating are arranged so that their respective deviations counter-balance, to make a more "straight-through" optical system. The system aperture is 8 centimeters, and the focal length is 60 centimeters. The spectra obtained have a normal dispersion of approximately 25 Å/mm in the first order. The grating is a Bausch and Lomb transmission replica, blazed for

5500 Å and giving bright spectra in a region for which the lens is well corrected—that is, from 4000 to 6000 Å.

Direct photographic copies of slitless spectra obtained elsewhere are not available, so detailed comparison of our results with other work is not possible. However, the superior optical specifications of the present equipment make it clear that greatly improved resolution can be expected. That this is in fact the case is especially well shown by the resolution of a pair of lines at 5001 and 5005 Å (N II) and by several sharp, faint lines near the strong N II line at 4630 Å (see Fig. 2). The hydrogen line, H-beta, appears very much broadened, and its intensity varies from one spectrum to another. The atomic hydrogen is, of course, derived from the dissociation of water vapor in the discharge.

During the period from 21 July to 8 October 1960, 97 films were exposed during 13 successive storms. On these

films appear 14 good grating spectra, comparable to those shown in Figs. 3 and 4. There are 19 of inferior quality, not suitable for detailed analysis but probably useful for purposes of classification and statistical study. All the films have been impressed with spectrum-densitometer standards. In addition, there are ten well-exposed prismatic spectra, produced by strokes fortuitously imaged by the prism and the zero order of the grating. They are of very low dispersion and hence are unsuitable for a detailed study of individual lines, but the relation between intensity and wavelength at selected points along these spectra should be significant. This is particularly true with respect to the streaks of continuous spectrum at isolated points (so-called "beads") along the discharge channel. It is important to determine whether these "hot spots," as I call them, are merely places where there is an over-

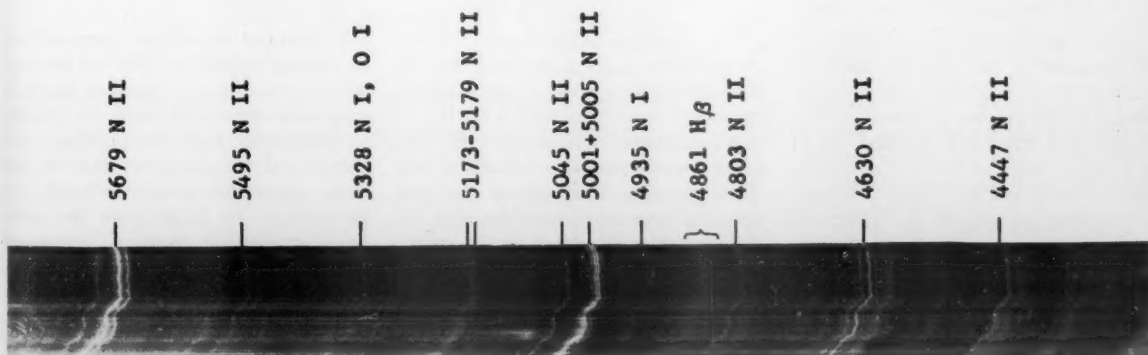


Fig. 2. Enlarged section of slitless spectrogram of lightning, with a representative group of lines identified. The photograph is oriented with the shorter wavelengths to the right, to match the orientation of the spectra in Figs. 3 and 4.



Fig. 3. Slitless spectrogram of lightning, focused for the green-yellow region. The spectrum extends from 6200 Å on the left to 4000 Å on the right. The bright central line is the 5001- to 5005-Å pair (N II); the intense line at the left is 5679 Å (also N II). Note the conspicuous absorption band (H₂O) between 5900 and 6000 Å.

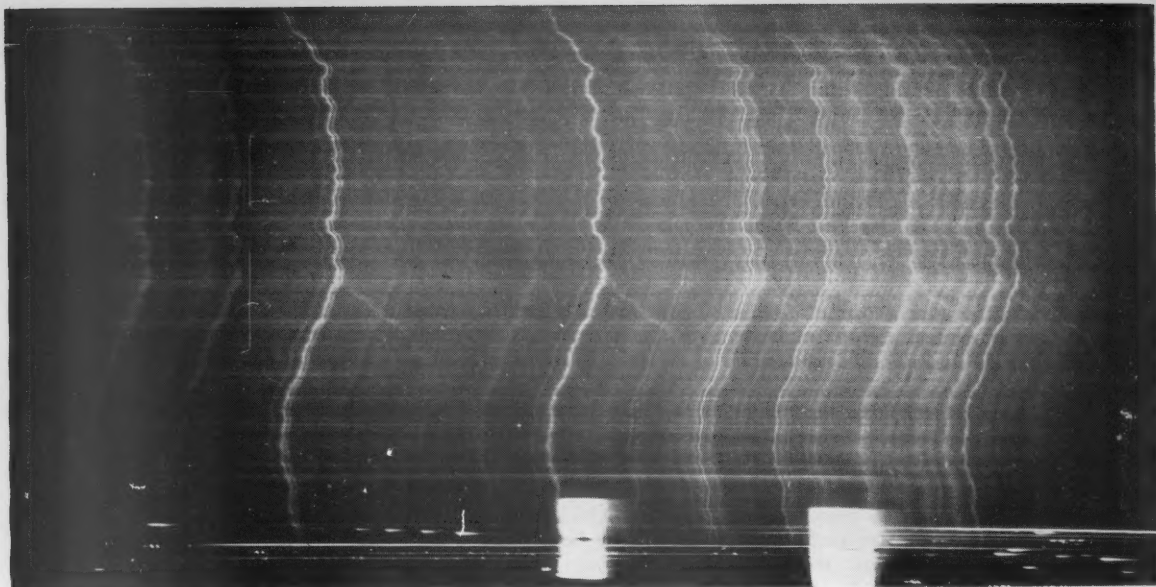


Fig. 4. Slitless spectrogram of lightning, focused for the blue-violet region. The last strong line on the right is 3995 Å (N II). The bright line in the center is the 5001- 5005-Å pair (also N II). Much fainter lines are visible farther to the violet, down to about 3800 Å. The sharp drop-off in intensity of the spectrum in the ultraviolet is due to absorption in the glass optics.

exposure due to chance orientation of the channel in the line of sight, or whether they represent an intrinsic change in the relative amounts of continuous and bright-line emission. Israel and Wurm noted an increase of excitation at such points. These continua, if real, may correspond to regions of immense magnetohydrodynamic forces, as the huge current flows around sharp bends in the channel.

Preliminary Findings on New Spectral Photographs

At the time of this writing, only the region from about 4000 to 5500 Å has been studied in detail, on two of the best grating spectra. However, it is already clear that the great majority of lines can be assigned to N II, with lesser numbers assigned to N I, O II, and O I, in that order.

On one strongly exposed spectrum a faint line at 4806 Å has been tentatively associated with ionized argon. This line has not been found on other spectra so far examined; if confirmed it will be the first identification of A II in the lightning spectrum. The 4806-Å line is the strongest member of the $4s^2P-4p^2P^o$ multiplet; there is no indication of a somewhat weaker line at 4736 Å, belonging to the same multiplet.

The variation in the intensity of H-beta is very interesting. On the basis

of a preliminary examination of a few of the better spectra, it seems that its strength is proportional to the intensity ratio 4935 Å (N I) to 5045 Å (N II).

A qualitative comparison of our spectra with laboratory spectra of the spark and arc in air shows that the lightning spectrum resembles that of the arc rather than that of the spark. Evidently the high current density is more significant than the high potential in fixing the prevalent state of ionization. This circumstance will explain an observation by A. Vassy (18) that the lines of N III and O III appear in the spectrum of long sparks but not in lightning.

A wide absorption band, extending from approximately 5900 to 6000 Å, shows clearly in the more strongly exposed spectra (see Figs. 3 and 4). This band is due to water vapor in the intervening air path, as was first suspected by Dufay (11) and later confirmed by Hu Ren-Chao (17).

No emission features have been found which can be attributed to molecules. In fact, a search has been made to confirm the occurrence of band heads in the systems of N_2 and N_2^+ , noted by Israel and Wurm and by Dufay in their slitless spectra. The result has been negative. The absence of molecular bands in slitless spectra is not surprising when one considers that here, as Vassy (18) pointed out in 1954, we have the spectrum of only the vio-

lent principal discharge, characterized by intense ionization. The slit spectra, on the other hand, represent multiple exposures, from reflections by clouds, of light from both the principal discharge and the afterglow. It is in the latter source that molecular bands can be emitted. To judge from the published tracing of Wallace's spectrum (16), this is very definitely the case.

Notes added in proof: 1) On a slitless spectrum obtained 23 June 1961, in Tucson, the N_2 and CN bands between 3850 and 3914 Å appear very strong, while the 3995 line of N II is comparatively weak. A re-examination of the spectra from the 1960 season has shown that these molecular bands have indeed appeared faintly in several instances, but it is clear that this most recent spectrum is quite unusual. No explanation of this apparent anomaly is forthcoming at the moment.

2) In the Russian news magazine *Krasnaya Zvezda* (issue of 3 June 1961) it is stated that Y. Zhivlyuk and S. Mandel'shtam have determined the temperature of lightning discharges to be about 20,000 degrees from slit spectrograms taken in 1958. [See also *J. Exptl. and Tech. Phys. U.S.S.R.* 13, 338 (Aug. 1961)]. It is interesting to compare this determination of temperature with that of Wallace, given in his 1960 paper. The latter used the N_2^+ bands around 3825 and 3900 Å, and obtained temperatures ranging between 30,000

and 6000°K—depending upon how much allowance was made for overlapping by the CN band near 3825 Å!

3) On 17 August 1961 the first *time-resolved* spectra of lightning were obtained in Tucson, with a drum camera attached to the spectrograph described in this article. Spectra of the brighter components of multistroked flashes are separated, rather than superimposed. Some of these spectra are superior in detail to any obtained heretofore. In certain cases the spectrum of the afterglow has been separated from that of the principal discharge.

References and Notes

1. In slitless spectroscopy a line-like source acts as its own slit and collimator when placed at a considerable distance from a camera equipped with an objective prism or grating. The resulting spectrum is really a series of monochromatic images of the entire source (rather than of a slit, as in conventional spectroscopy). By noting the relative widths and intensities of selected "lines" at various positions in the source, one often can infer a good deal about the distribution of temperature, pressure, and ionization.
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Federal Support of Research Careers

Government joins universities to increase the number of career appointments in research.

James A. Shannon and Charles V. Kidd

For some years it has been evident to qualified observers that the absence of adequate numbers of stable career opportunities for scientists has been an increasingly important barrier to the establishment of a sound research structure for the nation as a whole.

During and since World War II, university research in the United States has been heavily dependent for support upon federal grants and contracts. This support is often, although not always, provided for long periods of time. In many fields of science, support for research has grown at a pace exceeding the capacity of universities to staff the programs from their regular sources of income. The staffing problem has been solved in various ways. Large research organizations have been set up outside universities. Government laboratories have been expanded. Finally, universities have adopted practices enabling them to undertake larger research pro-

grams without committing a correspondingly larger proportion of university funds. These practices have included such steps as payment of the salaries of faculty members and other professional people from research grant and contract funds.

Increasing numbers of investigators, particularly at the assistant and associate professor levels, receive all or a large part of their income from research grants and contracts. This situation arises not from reluctance to pay staffs from stable funds, or from misgivings as to the quality of the group whose salaries are derived from grants and contracts. The research programs of the nation have simply expanded more rapidly than the financial base of stable funds available to universities. This development has been necessary to expansion of research in universities, but it has had some unfortunate consequences. First, the number of investigators whose salaries are dependent upon renewable research grant or contract support has now become so large as to create an

unhealthy degree of uncertainty as a built-in characteristic of the system. Second, many of the individuals concerned, and their families, lead a sort of hand-to-mouth—or grant-to-grant—existence. This is not conducive to the best work, nor is it an equitable arrangement. Third, the salary arrangements have tended in academic institutions to be a devious force, by creating a group of scientists who have few—and in many cases no—teaching responsibilities. Finally, the system does not provide an adequate investment in the future research capacity of the nation by strengthening the teaching process to the optimum degree.

The Public Health Service, with the approval of the Congress, is in the process of initiating a program aimed directly at the solution of these problems in the fields of medical and related research. This article deals with the development of this program for increasing the stability of research careers in medical research through the grant program of the National Institutes of Health. In this presentation, in addition to defining the principles of the operation of this new program, we discuss some of the problems which have arisen during the early stages of its implementation. Most of these stem from new relations that are emerging between the federal research support programs and institutions of higher learning.

In essence, this is a case study of the problems which arise when the federal government supports research in universities which have responsibilities extending beyond research to teaching. If the federal government looks to the research capacity of the nation 10 or 20 years in the future, as well as its current research capacity, it must be concerned with the ability of the people who will be investigators in the coming

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decade and beyond. Those people are now students, and they are being taught in universities. Accordingly, if the federal government's concern for medical and related research is to be a continuing concern, it must take into account the training of investigators for the future, as well as the support of scientists who are now fully trained. This transition from support of medical research in a narrow sense to support of the full structure and range of activities necessary to provide a sound scientific program in medicine and the related sciences for the indefinite future is the central problem of federal research policy in this area of research support. The problems involved in establishing a sound program for supporting careers in research are a specific aspect of the more general problem.

The Committee of Consultants on Medical Research to the Committee on Appropriations of the United States Senate issued in May 1960 a report, "Federal Support of Medical Research," which recommended that: "Funds should be provided through the National Institutes of Health in fiscal year 1961 to support the establishment of 200 research professorships in medical and dental schools and the basic science departments of colleges and universities at a salary level of \$20,000 a year, the funds to be made available to, and administered by, the respective institutions."

Subsequently, \$2 million was appropriated for this purpose, and an announcement of the plan to establish a "research professorship award" was made. The guides for administering this program, although issued at that time, were subsequently withdrawn and revised. The original guides were as follows.

1) Schools could nominate full professors (with provision for nomination of associate professors in unusual circumstances.)

2) Awards would be competitive, and selection would be based upon the distinction of the nominee. In the words of the brochure announcing the program, "Career Research Professors will be selected for support on the basis of demonstrated capacity to pursue with distinction a professorial career in independent research and teaching," in the fields of medicine, dentistry, public health, and related sciences.

3) Schools could nominate persons with tenure, and with income derived from stable sources, provided they agreed to use the released money for other professional positions in the school.

4) Awards would be for 5 years and would be renewable.

These guides were discussed with a large number of individuals from universities and with representatives of professional organizations. At that time, questions raised by these individuals related chiefly to such matters as the eligibility of faculty members with administrative duties, the firmness of the federal commitment to provide stable support, the fate of the award if the awardee changed schools, and other matters largely of an administrative nature.

Problems with the Original Program

Over the ensuing months, as institutions selected candidates under these initial guidelines, some more fundamental questions arose in the minds of persons in the institutions and in the federal government. These were as follows.

1) Some institutions had begun to have misgivings over the terms of a program which involved the federal government, even indirectly, in the selection of professors.

2) Some institutions were reluctant to make nominations because they did not wish to place full professors in national competition with each other or with professors from other institutions.

3) Other institutions were reluctant to make nominations because they felt that the award would not be stable, basing this view upon the words of the guide indicating that the awards would be initially for 5 years with a promise of support for the additional years, contingent upon annual appropriations.

4) On the part of the federal government, it was realized, as applications were received, that there had not been an adequate understanding with the universities as to the nature of the commitments that both they and the federal government should assume if a program for career support were to be fully acceptable and productive, and of the qualifications of candidates.

5) When the applications were reviewed as a group, it was found that a high proportion of the applicants were full professors of high distinction who were approaching, or who had entered, the final stages of their careers. Each institution acted in good faith within the terms of the guides, but the group as a whole did not possess characteristics in accord with the intent of Congress.

6) It was also found that a high pro-

portion of the nominees were full professors with tenure. The effect of the program would have been largely to release the university funds formerly used for the payment of the salaries of full professors for the appointment of junior faculty. This was not the intended major effect of the program, as described to and accepted by the Congress. Thus, the desired objective of providing greater opportunities for stable career support for individuals paid from grant funds would have become a secondary and purely fortuitous result of the program.

No one of these reservations was conclusive. Some of them were mutually exclusive, and they were given various weights by those concerned with the program. But in total, they constituted substantial reason to review with care both the fundamentals and the operating guides for the program. Such considerations led the National Advisory Health Council, a group of citizens advisory to the Public Health Service, to pass a resolution on 15 March 1961 which recommended "That the Career Research Professorship Program, in its present form, be abandoned before implementation in the form of specific awards."

In the light of this resolution and of further consideration of the applications and the guides, a Committee on Career Research Professorships, which had been convened to make recommendations on applications, was asked to consider the basic elements of the program and to advise on its future.

On the basis of the considerations brought forward by this group, and of further deliberation, it was decided (i) not to make awards under the existing guides; (ii) to return the appropriated \$2 million to the Treasury; (iii) to revise and issue new guides as quickly as possible; (iv) to return all applications with a request that institutions review them in the light of new guides and make new nominations; and (v) to make awards in the second half of calendar year 1961.

Policy Questions Clarified

Experience with the original guides sharpened some points of policy which had hitherto not been clearly stated.

1) A program designed to provide stable career opportunities for the large group of capable investigators receiving support from unstable sources—largely grants and contracts—could not simul-

taneously serve effectively to provide awards to career research professors who would be selected for support on the basis of demonstrated capacity to pursue with distinction a professorial career. The program had to be designed to do one or the other.

2) A program designed to increase the number of scientists supported from stable funds could not be based on standards encouraging nomination of persons with assured positions and assured income. The program would have to be designed primarily for those whose incomes were derived from unstable sources.

3) There should be no possibility that the inference might be drawn from the program guides that the federal government was selecting professors.

4) If the program were to provide a source of income more stable than that provided by research grants, the federal government would have to make awards with the firm intention of continuing them for the productive careers of those selected. Awards in segments of 5 years, renewable upon review at the end of each 5-year period, would not provide the necessary stability.

5) Whether the program was designed solely for persons engaged full time in research and teaching, or whether those engaged in research and teaching on a part-time basis would be eligible, was a question to be decided. Furthermore, if only full-time persons were to be eligible, "full time" would have to be defined. The original guides were silent on this point.

6) A federal program designed to provide stable career opportunities in academic and other research environments involves a long-term relationship between the institution and the federal government. The institutions, as well as the federal government, must assume appropriate responsibilities for the career stability of those given federal awards. This question was not dealt with in the earlier guides.

The points enumerated above seem in retrospect to be the kind of conclusion that one would reach by quiet and fairly brief reflection. The fact that many experienced people from universities, foundations, independent research organizations, and the federal government did not reach these conclusions in the initial discussions bespeaks the complexity of the problems that arise when a new policy affecting long-range government-university relations is adopted by a federal agency, and particularly when answers must be stated quickly.

New Guides

The re-examination of the premises underlying the original program, and of the specific guides for the program, led to the development of a new program concept and a new set of guides. The program has been designated the "NIH Research Career Award Program." In summary, the revised program, which will go into effect during the federal fiscal year that began 1 July 1961, has the following characteristics.

1) The primacy of the intent to increase the number of stably financed academic and other research positions is established. Accordingly, candidates whose salaries are derived primarily from research grants or contracts and from similar sources of relatively short assured duration will be given preference.

2) Conversely, the objective of providing awards designed to recognize outstanding scientific excellence, and to provide status and prestige to the individual and his institution, is subordinate. The awards will be competitive, and the standards for awards will be high, but the area of competition will be primarily among those whose incomes are from sources of relatively short assured duration.

3) To provide a system for support of research careers, it is necessary to distinguish between various levels of career development, because the needs of individuals and institutions vary at different levels. Accordingly, two groups of awards have been established. "Research career development awards" are designed for those who are in the early years of research careers. To be eligible, candidates must have had at least 3 years of relevant research or professional experience after receiving the doctorate. Awards are for 5 years, renewable, upon adequate justification, for 5 additional years. "Research career awards" are designed for those with substantial experience who are already launched upon research careers; these awards will provide support for the full career of the individuals who are selected.

4) An important objective of the program is to strengthen research institutions, while providing support to individuals. To provide a continuing link between the individuals selected and their institutions, a number of ties to the institution are preserved under the program. Awardees are expected to participate in the general activities of the institution, including teaching. Awards

are not made to individuals but are made to institutions on behalf of individuals. The NIH award will be consistent with the salary scale of the institution for persons with comparable experience and accomplishments. Finally, the institution is asked to nominate for "career awards" only those whom it would wish to have as permanent staff. Taken together, these provisions should link the institution and the awardees effectively under a program which provides salaries from a federal agency.

5) The awards are intended to provide sufficient compensation to permit those who are selected to devote their careers to research and teaching. Consistent with the principle that awardees are intended to be integral members of faculties, or of research staffs of non-academic institutions, the award will correspond to the salary paid by the institution to other persons with comparable attainments. Since the object of the program is to free people for careers in research and teaching, those who receive awards will be expected to devote themselves full time to these activities. However, the award recipients will be expected to engage in the usual ancillary activities of faculty members, such as writing, delivering occasional outside lectures, and serving on advisory groups, and they may receive the usual compensation for such work. Awardees will also be expected to practice their professions, as may be indicated, in connection with their teaching and research duties, and in order to maintain their professional skills. However, they may not retain personal income from practice.

Scope of the Program and Its Future

The program has been devised to meet very clearly defined and limited objectives. Accordingly, many individuals of high competence will not be eligible, and many institutions may find that they either cannot or do not wish to nominate persons for awards. For example, some medical schools which permit their faculty members to retain substantial sums from the practice of medicine may feel that they prefer their present system and do not wish to make the changes required to make faculty members eligible.

The fact that candidates with unstable incomes will be given preference, and the concurrent administrative intent to sustain high standards of excellence, will

tend to concentrate awards below the senior academic levels. This is the case because the prevailing practice is to give first priority in the use of firm institutional funds to the payment of salaries to the most able senior faculty members. If the needs for firm funds for payment of salaries to outstanding persons progressing to senior positions expand more rapidly than the firm institutional funds available for salaries, the federal funds for career support will become progressively more important at the senior levels.

In terms of money, \$4 million is available in the year that began 1 July 1961 for the Research Career Award Program. It is anticipated that this will finance about 275 awards.

As a long-range possibility, amalga-

mation of parts or all of this program with the new General Research Support Grant program will be considered. The General Research Support Grant provides broad aid for medical and related research, not support in the form of aid to specified projects or programs. The General Research Support Grant is a single grant to an institution, allowing it to meet those direct costs of research not covered by other forms of research support which are, in the judgment of the institution, most urgent. For these grants, \$20 million will be available in calendar year 1962 to schools of medicine, dentistry, osteopathy, and public health. The grant will be increased and extended to other institutions engaged in medical and related research in subsequent years.

Biochemistry of Aging

The mechanism of aging presents a challenge to modern biochemistry and biology.

F. Marott Sinex

The present development of biochemistry and biology suggests that the question, "Why do we get old?" may be answered in the foreseeable future. There are now several ways of investigating the mechanisms of aging in the laboratory, and new insights are bound to come from work in associated areas. I shall attempt to review in this article some trends in research on the biochemistry of aging.

Mortality data provide one approach to the aging problem. Gompertz (1) observed that a plot of the logarithm of the death rate in the surviving human population against age is a straight line after maturity. A similar relationship has been found in other captive populations, such as rodents and *Drosophila* (2). In human beings, the death rate doubles every 7 to 8.5

years (3). This implies that there is a 100-fold increase in the probability of death between ages 35 and 85 (4).

If separate physiological variables are measured, such as maximal breathing capacity, renal plasma flow (5), integration of complex mental skills, and speed of voluntary responses (6), there is a definite decrease with age, although this decrease seldom exceeds 30 to 50 percent (4, 5, 7).

When an explanation of this impaired function is sought in tissue pathology, a number of changes are observed. In certain areas of the brain there is a decrease in total numbers of viable cells, amounting in some areas to 25 to 30 percent, together with a decrease in the total amount of brain tissue—a decrease which may be of the order of 9 to 17 percent. At the same time, aberrations appear in the cytoplasm and nucleus of nerve cells (6).

To view federal support for research in universities in perspective, the Research Career Award Program represents a shift towards emphasis upon the long-term support of highly qualified people for research and teaching, as contrasted with support of current research. The General Research Support Grant represents a trend, evident in the actions of a number of federal agencies and most explicitly in the institutional grant of the National Science Foundation, toward aid to research and education on a broad basis, detailed determinations being left to the institutions. Accordingly, the long-range relationships between the programs must be taken into account in considering the evolution of the grant programs of the National Institutes of Health.

Decrease in strength may result from a decrease in the functioning mass of muscle as well as from an impairment in innervation. Evidence for the replacement of muscle fibers by connective and adipose tissue in older animals has been reviewed by Andrew (8), who attempts the difficult task of correlating what is known of the changes with age in skeletal, smooth, and cardiac muscle.

The age decrement in discrete renal functions can be attributed to a loss of functioning nephrons. The relationship between number of functioning units and functional capacity in kidney and other tissues is reviewed by Shock in the AAAS publication on aging (7).

In spite of the great current interest in hormones and the aging process, the exact relationships between endocrine function and aging is not well understood. Pincus (9) has reviewed much of the literature on this subject and attaches particular importance to the function of the pituitary.

Enzymes

To the biochemist the subject of enzymatic activity of aging tissue is of great interest. It is not always easy to distinguish between the amount of an enzyme present in a tissue and the activity of the enzyme. It is particularly difficult to measure the amount of inactivated enzyme which might be present in tissue as a consequence of

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the passage of time. Very little is really known about the rate of replacement of enzyme in resting cells. Barrows, Yiengst, and Shock (10) have stressed the importance of expressing enzymatic activity on a per-cell basis, using deoxyribonucleic acid (DNA) content as an indicator of the number of cells in making comparisons between young and old animals in situations where cells are being replaced by elements of connective tissue.

In certain instances, changes in enzymatic activity can be attributed to a decrease in the number of intracellular elements. Barrows, Falzone, and Shock (11) reported that the decrease which they had observed in the succinoxidase of rat kidney was associated with a decrease in the number of mitochondria per cell. On the other hand, Weinbach and Garbus (12) found that hydroxybutyrate metabolism by liver and kidney mitochondria decreases with age. Of particular interest are the observations of Barrows (13) that the catheptic activity of the liver increases markedly with age. A phenomenon commonly associated with aging, the greying of hair, may be due to a loss of tyrosinase activity of the melanocytes of the hair bulb (14).

Within recent years there has been a better appreciation of the necessity of correlating morphological changes, both within the cell and in the total cell population, with observed levels of enzymatic activity.

Ionizing Radiation

Ionizing radiation produces many changes analogous to those observed during normal aging. It decreases life expectancy; there is a shifting of the Gompertz function on the time axis. That is to say, the death rate of animals in any particular age group is greater after radiation. Or, to put it another way, after radiation the observed death rate corresponds to the death rate in an older age group. The slope of the function does not change in animals exposed to a single dose of radiation. As a consequence of radiation injury there is a decrease in the number of viable cells in many tissues, and these cells are often replaced by elements of connective tissue. In many cases the pathological changes which occur resemble those found in normal aging. But this is not to say that the

injury sustained from ionizing radiation is identical to aging; the reader interested in more exact comparisons is referred to the reviews by Upton (15), Strehler (16), and Handler (17).

Pigmentation

There is an increase in pigmentation of a number of tissues associated with aging. Some of these pigments are extracellular, some intracellular. Many exhibit blue or yellow fluorescence in ultraviolet light. The pigments of heart muscle (18, 19), neurons (20), atheromatous plaques (21), and elastin (22) have attracted particular attention. Histological terms such as *lipofuscin* and *ceroid* are used to describe these pigments as they are observed in tissue sections. Pearse (23) gives an excellent discussion of the ways in which liquid peroxides, lipofuscin, and ceroid are distinguished histochemically and morphologically. The most generally held view is that these pigments result from the auto-oxidation of lipid.

Harman (24) was among the first to implicate auto-oxidation of lipid and the interaction of auto-oxidized lipid with protein as a factor in aging. Auto-oxidation of lipid *in vitro* is characterized by an induction period in which oxidation is initiated and antioxidants are destroyed (25). Peroxides form, and systems of double bonds conjugate. Carbonyl compounds, particularly aldehydes, appear (26). Many of these products are capable of condensation and polymerization. The products of auto-oxidation are pigmented, fluorescent, tough, insoluble films that precipitate with many of the properties of ceroid (27) and lipofuscin (18, 19).

Attempts to isolate pigment from the tissues of senescent animals have been successful only in the case of the lipofuscin of heart muscle. The cytoplasmic granules of age pigment of heart muscle were isolated by Heidenreich and Seibert (18), using density-gradient techniques. Mildvan and Strehler (28) have reported that these intracellular granules may be identified with tissue particulates known as lysosomes. They found that lipid extracts of such granules chromatographed on silicic acid columns revealed a pale blue fluorescence in the cholesterol ester fraction and a yellow orange band in the cephalin fraction.

Chromatography of peroxidized cephalin on paper gave a pattern similar to that obtained from the column fraction.

The yellow age pigment of nerve cells has never been isolated. Heyden and Lindstrom (20) have studied its spectra in tissue sections. Sulkin (29), who is currently investigating the nerve-cell pigment, feels that the pigment is lipoidal in origin and resembles ceroid. Duncan, Noll, and Morales (30) feel that the pigment arises in mitochondria.

There is extracellular pigmentation associated with aging in blood vessels. Atheromatous plaques are reported to contain ceroid (21) and lipid peroxides (31). Preparations of acid-solubilized elastin from older animals appear more yellow. This yellow fluorescent pigmentation associated with elastin is also found in ligamentum-nuchae elastin. Partial hydrolyzates of elastin prepared with either elastase or dilute acid are yellow and fluorescent. Fluorescent pigments can be prepared from both partial and complete hydrolyzates (32, 33). Loomeijer (33) believes that lipid-soluble pigments derived from elastase hydrolyzates are derived from auto-oxidized lipid. Work in our own laboratory, as yet unpublished, also causes us to believe that the water-soluble pigments of both elastase and acid hydrolyzates are derived from auto-oxidized lipid.

The degree of functional impairment from the accumulation of such pigment is difficult to evaluate. Strehler, Mark, Mildvan, and Gee (19) find that lipofuscin can account for 3 percent or more of the wet weight of cardiac muscle. Nishida and Kummerow (34) report that linoleic peroxide interacts with beta-lipoprotein in such a way as to alter its electrophoretic pattern, and they suggest that lipid peroxides may play a role in the accumulation of lipid in intima. Interpretation of the relationship between auto-oxidation and aging is complicated by the observation that accumulation of age-associated pigments in neurons is accelerated by deficiency in vitamin E, administration of acetanilid, and stress (29).

Connective Tissue

Interest in the role of connective tissue in aging arose from the fact that unquestionably there are differences between the connective tissue of young

and of old animals (35). Both the amount and the character of connective tissue may change. In some tissues, the disappearance of cells is accompanied by replacement of the cells by elements of connective tissue.

Changes in connective tissue can arise from a variety of causes, including alterations in endocrine function (36) that stem from changes in the types of cells represented in the total population, or from chemical changes within the extracellular phase. Gross (37) has suggested that chemical changes similar to the extracellular changes occur within cells during aging, for which the aggregation of collagen might serve as a model.

In connective tissue there are changes in the mucopolysaccharides present. Davidson, Woodhall, and Baxley (38) report a gradual accumulation of keratosulfate with age in cartilage, nucleus pulposus, and other tissues.

With advancing age collagen becomes tougher, more crystalline, and more difficult to dissolve. Elastin in human blood vessels appears less elastic and fragments with age. This fragmentation is associated with calcification and pigmentation (39).

In the ground substance there may be an increase in density and aggregation. The significance of such changes is difficult to evaluate, but they may influence the nutrition of cells. Gersh and Catchpole (40) postulate that all interchanges between ground substance and epithelium must occur through two basement membranes, consisting of aggregated ground substance, the permeability of which probably decreases with age. However, if a dispersed colloid aggregates into a more aggregated and a more aqueous phase, diffusion through the aqueous phase may increase. In one of the few attempts that have been made to measure diffusion in young and old tissue, Kirk and Laursen (41) actually found increased diffusion coefficients for nitrogen, oxygen, carbon dioxide, lactate iodide, and glucose in intima and media of older subjects. In some instances aggregation may decrease in senescence. Banfield and Brindley (42) report that the extractability of abdominal skin collagen in 0.1-percent acetic acid increased in subjects between 40 and 80 years of age.

The question of decreased vascularization and arteriocalillary fibrosis of aging tissue is another aspect of the problem of diffusion of essential nu-

trient. Changes occur with age in the reserve supply of blood and in the distribution of blood to tissue. The diminution in cardiac output, with age, of approximately 1 percent a year (15-17) is in part a reflection of increased peripheral resistance. It is important that all the factors responsible for this increased resistance be recognized, and that morphological changes in the barriers between capillaries and cells be analyzed both in terms of physical chemical changes in mucopolysaccharide, collagen, and elastin and in terms of the properties of the living cells of the vessels. The question of the vascularity of aging tissue is reviewed by Landowne and Stanley (43), and by Handler in the recent AAAS symposium on aging (17).

Lability of Macromolecules

It is possible that aging results from chemical changes in irreplaceable macromolecules (44). Altered molecules may accumulate in postmitotic cells and in elements of connective tissue with limited rates of replacement.

The time-dependent chemical changes postulated may be of a variety of types, and may include thermal denaturation involving unfolding of tertiary structures (45), hydrolysis of amide and peptide bonds (46), and oxidation (47). Among the proteins which might not survive a lifetime of incubation at 38°C is the extracellular protein elastin. Since it is less crystalline than collagen, it does not have the added protection of extensive hydrogen bonding to protect it against thermal denaturation and other deleterious chemical changes.

Aging and the Gene

There is evidence to support the belief that many of the changes which accompany aging occur in the nucleus. Such evidence includes the observation of abnormal nuclei and abnormal cell division in senescent animals (8), as well as the difficulty which adult tissue has in initiating the first mitotic events in tissue culture or after stimulation.

Adherents of the theory that aging is centered in the nucleus generally believe either that aging is an extension of normal differentiation or that it is due to accidental genetic noise.

The first group points out that, while we as individuals may view aging as a

catastrophe, it probably serves a useful evolutionary purpose in insuring succession of generations. Insect physiologists and plant physiologists are particularly likely to hold this view. Many insects, in the adult form, have a relatively short life expectancy and may even be born without mouth parts. In such insects differentiation produces a phenotype with a limited life expectancy. The death of an annual plant often appears to be the final step in an orderly development. One may therefore argue that aging is a deliberate event, consisting of differentiation to a point where the interdependence of tissue and cells is incompatible with the indefinite life of the total organism. The deaths of individuals, could however, contribute to the survival of the species by insuring a progression of generations and reducing competition, for the food supply between young and old. Dobzhansky has ably presented aging as an adaption of evolution (48).

A second group holds the view that aging arises from genetic noise or random somatic mutations. Henshaw (49), Failla (50), Szilard (51), and Strehler (16) have all discussed theories of aging based on somatic mutation. These are reviewed by Glass (52) in the recent AAAS publication on aging.

The rate constant for somatic mutations viewed as chemical reactions would be very small, possibly of the order of 10^{-30} . If genetic material had the thermal stability of purified DNA (53), there would be little probability of thermal mutation, because of the great stability of the hydrogen-bonded DNA helix. On the other hand, in certain cells, genes may be considerably less stable than purified DNA. The rate constant for thermal mutation of *Escherichia coli* and *Bacillus subtilis* is of the order of 1×10^{-6} at temperatures between 55° and 60°C (54). Human genes of this order of stability might undergo considerable spontaneous somatic change at 38°C. Such deductions, however, must remain speculative until they can be made to rest on firmer experimental evidence. It will be difficult to demonstrate that random somatic mutations do occur in aging tissue, particularly if such mutations are truly random. However, an effort should be made to ascertain whether clones of cells from aging individuals have altered biochemical properties. The greying of hair might be an ex-

ample of a somatic mutation in aging melanocytes (14).

A particular aspect of genetic interest concerns the instructive theory of antibody formation. Is there an impairment in self-recognition in aging animals due to alteration in either antigen or antibody?

Somatic theories of aging have appeal to those who feel that ionizing radiation also produces somatic mutations, for such theories would explain the similarity between aging and radiation injury.

Free Radicals

The similarity between certain aspects of radiation injury and aging may reflect common physiological and cellular impairments or, as suggested by Harman (55), may be due to analogous chemical events, such as free-radical reactions (56), occurring in both radiation-induced and normal aging. Concepts based on the chemistry of the free radicals produced by ionizing radiation have proved very helpful in explaining the biological effects of such radiation (57).

There is a growing body of evidence, based on findings of an accumulation of pigment believed to arise from auto-oxidized lipid, that auto-oxidation occurs in senescent tissues. It is thought that auto-oxidation proceeds by a free-radical mechanism, with formation of peroxides and of both carbon and oxygen radicals. More attention should be given to the substances which might initiate such reactions in tissue, such as trace metals, hematin, hydrogen peroxide, or oxygen itself. Free-radical hypotheses have the attractive feature of suggesting that preventive therapy with specific antioxidants is a possibility.

Summary

It should be apparent that while no one really understands all the fundamental mechanisms underlying the aging process, progress is being made, and theories are being advanced which may be tested in the laboratory.

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Science and the News

U.N. Debate on Nuclear Tests: It Is Taking a Good Deal of Time and Leaving Nobody Very Happy

The United Nations political committee has spent most of the month debating what to do about the collapse of the nuclear testing moratorium, an issue that has produced a great sense of frustration among the neutralist delegates who, in the course of the protracted debate, referred frequently to their feeling of helplessness to move the great powers. There has been an almost equally strong sense of frustration among the American delegation at what appears to the Americans as a willful and irresponsible failure of the neutrals to face up to the difference between Soviet and American actions on the test ban. One result of this has been that the most bitter exchanges of the debate have not occurred between the Americans and the Russians, but rather between the Americans and the neutralist Indian delegates.

The debate opened with two weeks of wrangling over whose resolution should be debated first. The Russians wanted to talk about complete and general disarmament. They argued that a new test ban could now be gotten only as part of a general disarmament agreement which, they said, could be achieved very quickly if the Americans were really interested. The Americans and British wanted to talk about a test-ban treaty with controls, which, they said, could be achieved very quickly if the Russians should decide to renew negotiations with a real intention of coming to an agreement. The Indians, with the backing of nearly all the neutralist delegations, wanted to discuss a new moratorium to stop tests immediately.

Neither the Russians nor the Americans had any expectation that their proposals would get priority. The mood of the neutrals made it certain that the Indians' appeal for a new moratorium

would get first priority, even though both the Russians and, more emphatically, the Americans, made it clear they would reject it. To the neutrals the need was to stop all tests everywhere as soon as possible, and neither the Russian nor the American approach was going to produce this result, since everyone knew that neither the American talk of a quick agreement on a treaty nor the Russian talk of a quick agreement on general disarmament was anything more than talk.

The Russians, with no chance of getting priority for their general disarmament proposal, were quietly satisfied with the likelihood that the Indian-sponsored call for an unpoliced moratorium would get priority. It would apply with equal force to both the Russian tests in the atmosphere and the American tests underground, and it could, after the conclusion of the current Russian tests, be conveniently accepted, if the Russian government chose to do so. The Americans, for the same reasons, were thoroughly unhappy with the Indian proposal, but, with no chance for gaining priority for the Anglo-American proposal for a treaty with controls, they settled for a resolution allowing the Anglo-American proposal to be debated simultaneously with the Indian proposal, but with the Indian proposal for a moratorium to be voted on first. India and a dozen other neutralists joined the Soviet block in opposing even this slight concession to the Anglo-American position, but most of the neutralists abstained, allowing the American-sponsored resolution to go through by a comfortable margin.

To the Americans the issue was very clear: the Russians had broken the moratorium; they had gone back on agreements that had already been reached at Geneva; they had been preparing an elaborate series of tests while the Americans and British had been negotiating in good faith; they had made it clear that they were not pre-

pared to accept a controlled ban on underground tests; they were contaminating the atmosphere with a lengthy series of large explosions. In response to this, the neutralists, led by India, proposed merely to appeal to both sides, as equally guilty of breaking the moratorium, to renew the moratorium, giving no consideration to the relative awkwardness with which the West and the Russians could accept an indefinite uncontrolled moratorium, to the course of the negotiations in the past year, or to the now plainly stated lack of Russian interest in accepting controls except as part of a general disarmament agreement which no one really believes can be reached in the reasonably near future. From the American point of view, then, the mood of the neutralists was impartial in the sense that Anatole France pointed out that "the law, in its majestic equality, forbids the rich as well as the poor to sleep under bridges . . ."

Harsh Words

When V. K. Krishna Menon, speaking for India, delivered a lengthy "plague on both your houses" speech, Ambassador Dean replied for the United States with a lengthy attack on the Indians for, in effect, playing into the Russians' hands by equating the positions of the two governments. The exchanges went on through last week, and are probably still continuing. Menon, in his major speech, quoted from statements in the American press to demonstrate that the Americans did not really want a test ban; that Project Vela (to improve the detection of underground tests) was intended for weapons development; that the holes for underground tests were enormously expensive to construct, with the implication that either the Americans had prepared fully as arduously, while the Geneva negotiations were going on, for the few underground tests that have been conducted as the Russians had for the elaborate series of atmospheric tests, or that the expenses of carrying on a full-scale set of underground tests would be so enormous and time-consuming that the Americans did not have to worry about the Russians' attempting to carry out such testing even with a system of controls. Menon insisted that the Indians were fully in favor of controls anyway, but that they felt testing should not go on while the details of the control procedure were being worked out.

To the Americans a good deal of what Menon had to say was simply outrageous. The Indians would have been equally outraged if an American delegate, for example, had picked out embarrassing or inaccurate or out-of-context quotations from the Indian press to present as items to be given equal weight with the statements of the Indian government regarding its policies; the quotations about the difficulty of preparing for underground tests came from a Congressional hearing concerned with what a nation would have to do to conduct undetectable underground tests if a system of controls and inspection were in force; the insistence that India recognized the need for control was less than completely candid in the context of the situation, in which there was no likelihood of the Russians' accepting controls, and in which, therefore, an appeal for a moratorium pending the establishment of controls was tantamount to an appeal for an indefinite moratorium without controls.

Neutralist Feelings

The basis for the Indian attitude, which was substantially echoed by many of the neutralist delegates, although in terms less offensive to the Americans, was the general feeling that both great powers were going to do what they felt their national interest demanded, no matter what kind of resolution the U.N. passed; that both powers had argued on both sides on many of the points at issue, depending on what argument happened to suit their purpose best at a particular time; that both sides were devoting themselves too enthusiastically to trying to win momentary propaganda advantages instead of trying to avoid a nuclear holocaust; that it was difficult to know just which side had the more honest arguments without access to the confidential information on which the top officials of both sides were making their policies; that it would not be good to add fuel to the Russian feeling that the U.N. serves the interests of the West by passing a resolution that too clearly makes the Americans happy; that the whole business was, in short, very touchy, very complicated, and that the one thing the U.N. should clearly do is to renew its often stated position that it is against all nuclear tests, anywhere, and any time. Privately, there was a good deal of revulsion at what the Russians were doing, but in public speeches, the consistent line was "we are against all

tests," and there was little support for a resolution that would not apply with equal force to both sides, despite the American criticisms about the unequal nature of the equality involved in such a resolution.

The Russians, though, were generous enough to do what the American delegation never would have been able to do. Khrushchev provided 10 days' warning before exploding his 50 megaton bomb, time, as it turned out, just sufficient to rouse the U.N. to pass a resolution asking him to forgo the test, despite the antipathy among the neutrals toward any resolution that would not apply equally to all the nuclear powers. There was no rush to do this, and a week passed between the Soviet announcement and a decision by the political committee to suspend debate on the general question of the test ban in order to push through an appeal to the Russians. On the vote to suspend the general debate India and a dozen other neutrals joined Cuba and the Soviet bloc in opposition. After the suspension most of these neutralists took the floor to make clear that, although they would vote for the appeal to the Russians, they regarded it as a mistake to make an appeal directed to only one side on only one test, and that they would regard their votes as votes against testing in general. On Wednesday of last week the resolution went through the political committee, with only Cuba and the Soviet bloc opposing, and only Mali, a new African state which usually votes with the Russians, abstaining. An attempt to add to the resolution the Indian appeal for an end of all testing was brushed aside. At the Friday session of the General Assembly, the last before the Soviet explosion, the delegates heard the Russians denounce the move as a piece of NATO propaganda and announce that they would not accept the appeal. Shortly after, at 8 in the evening, the Assembly voted the resolution through with, once again, only Cuba and the Soviet bloc opposed, and only Mali abstaining. But the neutrals quite obviously felt they had gone as far as they cared to go in supporting a test-ban move that could be denounced by the Russians, just as they have denounced the U.N. operations in the Congo, as U.N. support for the Western interests in the Cold War. When the Russians exploded their bomb on Monday, none of the neutralists' representatives joined the Western delegates in condemning the test,

nor was there any sign that the neutrals would support a resolution censuring the Russians for ignoring the U.N. appeal. Indeed, so far as the neutrals were concerned, the first order of business was now to rush through the Indian appeal to both sides to renew the moratorium, a resolution that almost certainly will have gone through by the time this appears. The best the Americans hoped for was that the U.N. would quickly follow the passage of the appeal to both sides for a new moratorium with a parallel appeal for a treaty with controls.

Atmospheric Tests

The debate has left everyone unhappy. The Americans and British have been pointing out that they, too, may have to resume atmospheric testing as a result of the Russian actions. This is partly because they feel they may well have to do so, but partly, as well, because there seems to be no other way to force the neutralists to recognize a distinction between Anglo-American and Russian behavior than by reminding them of what the Western powers might easily do in response to the Russian testing and thus, it is hoped, bringing them to face the difference between what the Russians have already done and what the West has already done. But the neutrals do not want to face any such difference; they do not want to be drawn into taking a position on issues between East and West; they do not want to recognize a great difference between underground testing and atmospheric testing because they do not want to be put in the position of seeming to imply that any kind of testing is all right which they feel would be the implication of an appeal for a moratorium on atmospheric testing only. This is particularly so when they do not trust either side and therefore are unwilling to take an anti-Russian position solely on the basis of Western arguments, which they do not have the information to evaluate independently, that Western security would really be threatened by an unpoliced moratorium on underground tests.

So the Americans are making an argument which the neutrals do not want to hear, because although it may be logical, indeed just because it is embarrassingly logical, it at once makes it more difficult for them to maintain their position without convincing them that their position is not really the right one to take.—H.M.

Food Packaging: Industry, Consumer Spokesmen Differ on Rationality in the Supermarket

Spokesmen for several segments of the food industry appeared before the Senate Anti-trust and Monopoly Subcommittee last week to reply to charges that artfully contrived packaging techniques are deceiving the consumer.

The charges, which consumer representatives made before the committee in June, basically are that the supermarket shopper is being duped with techniques borrowed from psychology, the visual arts, and other specialties. As a result of these practices, the consumer representatives said, it has become extremely difficult to make a "rational" choice among competing products.

Specifically, they complained of the obscuring of net content data on labels, slack filling of packages, and the practice of reducing the contents of familiar packages without a corresponding drop in price. In addition, they charged that some manufacturers deliberately fill their packages to fractional weights, such as the 3 pounds 1¼ ounces in a leading laundry detergent, to make cost per ounce computations extremely difficult.

The packaging industry is vast and amorphous, and the replies to the charges vary. But in essence, the principal counterarguments are that (i) any consumer interested in "rational" shopping can find all the necessary information on the label; (ii) practices described as questionable are well within the law and are sanctioned as acceptable competitive techniques; (iii) the few rotten apples that can be in any barrel should be attended to in this case by nongovernmental industry policing; and (iv) the producer who regards the consumer as rational does so at his peril.

The hearings on packaging are directed by Senator Philip A. Hart (D-Mich.), and are part of a long series of inquiries which Senator Kefauver, chairman of the over-all subcommittee, has undertaken into various aspects of the American economy. These inquiries, starting in 1957, have included the auto, steel, drug, bread, and insurance industries. None of these earlier subjects, with the possible exception of drugs, however, had elicited such broad and immediate public interest and approval as the inquiry into packaging. And because of this public response, none afforded the

committee the opportunity for such rapid exploitation of the congressional hearing as a device for public education (or propaganda, depending on one's point of view), political advantage, and spade-work for legislation.

The subject of value in food is one in which most shoppers feel personal interest, knowledgeability, and, because of the cost of living, frustration. A steady flow of commendatory mail indicates that they have responded warmly to the role undertaken by Hart, a first-term senator who was scarcely known outside of Michigan before the hearings and who now has a solid claim to the politically profitable role of champion of the consumer.

Sought After Role

The role, which is a coveted one on Capitol Hill, is also a politically dangerous one, for the championing inevitably must be against some element of the business community, which is alert and capable of vigorous self-defense. By shrewd management of the inquiry, however, Hart has managed to lead the packaging and allied industries to the conclusion that it would be in their own interest to abstain from counterattack. The principal device for obtaining this result has been a policy of masking brand names at the public hearings and insisting that all witnesses appear voluntarily, and not under subpoena. The gift of product anonymity assures that no producer will undertake a public relations campaign to defend practices of which he has not been publicly accused; and the insistence on voluntary appearances has assured a more gentlemanly atmosphere at the hearings, with no substance for a public plea that the industry has been dragged before a hostile congressional committee. With rare exceptions, the industry witnesses sought by the committee have come forward to respond to the charges.

These witnesses have been burdened by the difficult task of explaining away a variety of questioned practices against the background of Hart's simple and reasonable-sounding assertion that "The consumer has a right to be able to find out what he is buying, how much he is buying, and what it is costing on a per unit basis." The industry reply is that any shopper who seeks this goal can find the necessary data on virtually all products carried in supermarkets, and can make his own computations. Hart and the consumer witnesses, in turn, have not

disputed that the data are there—federal and state regulations assure that it is—but insist that many manufacturers have sought to de-emphasize it and have placed a heavy burden on the shopper who seeks to be "rational." To this, a number of packaging specialists have replied that the housewife is not a rational creature, and that the producer who pitches his sales campaign to the needs of rationality will go broke. Soap in a red box, they point out, sells better than the same soap in a brown box; coffee made in the same urn "tastes better" to a test panel when it is poured from a battered, well-used looking percolator than when it is poured from a new percolator; the use of the term "jumbo half-quart" fulfills a psychological need for plentitude without deceiving anyone about the quantity. In fact, argued Louis Cheskin, a motivational researcher with numerous clients and considerable influence in the food industry, "Our entire social structure depends on the mass production of psychologically satisfying products as much as the individual depends on these products in fulfilling his emotional needs." Any attempt, he said, to dictate minimum standards for the location and visibility of net content designations, might "mutilate the psychological appeal of the package."

Cheskin's testimony was similar to that of a more renowned motivational researcher, Ernest Dichter, who claims to have enlisted the insights of modern psychology in behalf of merchandising. Dichter, who appeared at the June hearing, testified that most competing products were similar in quality, and that the competitive edge goes to the company that can create the illusion of a desirable difference. The package, he said, is a crucial element in achieving this goal. Any attempt at dictating package design, he warned, was based on ignorance of what makes the market place work.

In response to the other charges, spokesmen argued that when a producer is faced with the need to increase his price to meet higher costs, it has been found that the consumers react more favorably to a drop in the contents, accompanied by maintenance of the original price. These spokesmen have attributed slack filling of containers to unavoidable settling in transit; and in answer to complaints of fractional weights that complicate cost-per-unit calculations, one spokesman, Roy King, editor of the trade journal *Food Field Reporter*, argued that "the consumer

views a given product in terms of volume usage, rather than airdupois weight. Although net weight . . . is included on the package because the law so decrees, the consumer views his purchase by so many cupsful, so many servings, or so many teaspoonsful. . . . The housewife," he declared, "is buying performance and service, in terms of usage. Fractional weights are actually of minor significance when compared to product performance."

While spokesmen for the industry have attempted point-by-point refutations of criticisms made at the hearings, various parts of the industry have taken steps which indicate a realization that the resentment expressed by consumers is intense and has now found an open channel for political action. One major chain store recently undertook a survey to make certain that its so-called large economy sizes cost less per ounce than the smaller sizes. A spokesman said it found a few that did not. And several associations of food packers have urged their member firms to reexamine their practices in the light of complaints made at the hearings.

These industry efforts will probably lead to a number of reforms which will be held up to the committee as proof that self-regulation and enlightened policies have removed whatever need there may have been for Federal action. The committee, however, has set forth consumer rationality as the value it wishes to support. The industry, by its own testimony, has come to regard this as an illusion, and whatever efforts it may make at self-control, the dynamics of the highly competitive, \$55 billion a year food business are likely to overwhelm any voluntary effort to encourage consumer rationality in the supermarket.—D.S.G.

A Boost for Educational TV

With few exceptions, educational television has been blocked from the pathways to large audiences. This has come about because the very-high-frequency band, for which most sets are exclusively equipped, is almost fully occupied by commercial stations. Educational television has a standing invitation to set up shop on the ultra-high-frequency band, but generally has been reluctant to do so because the number of UHF-equipped receivers is negligible.

Last week, the Federal Communications Commission acted to open the way for educational television broad-

casts that can be received on standard sets in the New York Metropolitan area. In an action still subject to court review, the FCC approved the sale of WNTA-TV, Channel 13, to Educational Television for the Metropolitan Area, Inc. The purchase price, \$6.2 million, has been subscribed by five commercial stations in the New York area, a number of foundations, and individual contributions. The operating expenses, estimated at \$2 million annually, will be solicited from the public.

The new station is expected to become the anchor of a thriving "fourth network" of some 50 educational television stations now in operation across the nation. These have provided elevated TV fare by pooling their resources for taped productions which they circulate among themselves. The new station's relatively substantial resources, along with the vast audience within its reach, will make this fourth network an increasingly influential force on millions of TV screens, much along the lines of what Walter Lippmann suggested when he wrote that the solution to the ills of television may be establishment of a network "run as a public service with its criterion not what will be most popular but what is good."

West Ford: Outcome Uncertain

The uncertainties of space technology have provided an anticlimax for the first attempt to carry out the controversial Project West Ford. At midweek, it appeared that the 350-million hairlike copper filaments that were carried aloft 21 October by a Midas satellite had failed to form the intended earth-circling belt.

West Ford's goal was to create an artificial ionosphere for experiments in long-range communications. Military planners regard the project as holding promise for a jam-proof communications system.

The announcement of West Ford brought protests from astronomers who contended it might interfere with radio and optical observations. Their fears were discounted by the President's Science Advisory Committee and the Space Science Board of the National Academy of Sciences.

It was reported that the canister containing the filaments apparently had separated from the satellite but had failed to discharge its load. Present plans call for another attempt if the belt fails to develop.

Announcements

A science resources planning office has been established by the National Science Foundation to study the nation's future needs and resources for research and education in science. The new office, headed by Richard H. Bolt, NSF's associate director of research, will use information developed in cooperation with educational institutions, industrial firms, and government agencies, and will sponsor relevant studies by other organizations, both public and private.

The American Academy of Allergy is requesting physicians to submit names and addresses of persons who experience severe allergic reactions to insect stings. Questionnaires on the subsequent sting history of persons in these various categories (to be completed by the patient) will enable the academy to determine how much treatment should be given, or what happens to the majority of these people if they remain untreated. (Executive Office, American Academy of Allergy, 756 N. Milwaukee St., Milwaukee 2, Wis.)

The Public Health Service's Communicable Disease Center in Atlanta, Georgia, has been designated the inter-American arthropod-borne virus regional reference laboratory for the World Health Organization, in recognition of the growing number of viruses carried by insects, spiders, and ticks. The new unit will offer reference diagnostic services to public health laboratories for detailed identification of arboviruses, and limited quantities of reference diagnostic materials to laboratories concerned with these diseases.

Psychologists who have recently completed research studies in human factors engineering under government contract are invited to submit manuscripts based on their findings for publication in the *Journal of Engineering Psychology*. (Elias Publications, P.O. Box 662, Washington 4, D.C.)

The American Board of Nutrition will hold the next examinations for certification in human nutrition on 8 April 1962 in Atlantic City, N.J. Deadline for receipt of applications: 1 March 1962. (Robert E. Shank, Department of Preventive Medicine, Washington University School of Medicine, St. Louis 10, Mo.)

The proceedings of the 5th World Forestry Congress (Seattle, Wash., 29 Aug.-10 Sept. 1960) will be published early in 1962. The price for advance orders, placed prior to January 1962, is \$25. A folder describing the contents of the three volumes is available on request. (V. L. Harper, 5th World Forestry Congress, c/o Forest Service, U.S. Department of Agriculture, Washington 25, D.C.)

Meeting Notes

A science writers' seminar on arthritis, sponsored by the National Foundation in cooperation with the Johns Hopkins Medical Institutions, will be held in Baltimore from 5 to 6 December 1961. The seminar, planned as a backgrounding workshop, will cover current knowledge and problems in research, treatment, and epidemiology of arthritis and rheumatic diseases. Registration deadline: 10 November 1961. (Charles Bennett, Science Information Division, National Foundation, 800 Second Ave., New York 17)

The second international congress of radiation research will be held in Yorkshire, England, from 5 to 11 August 1962. Papers, which must be unpublished at the time of the congress, may cover radiation physics; radiation chemistry; or radiation biology, including human radiation biology, and may be submitted in either English, French, German, or Russian. Deadline for registration (\$24) and submission of 250-word abstracts (five copies): 15 January 1962. (Alma Howard, Mount Vernon Hospital, Northwood, Middlesex, England)

Courses

A 10-week training session for secondary-school science teachers and supervisors will be held in Oak Ridge, Tennessee, from 8 January to 16 March 1962. The session, designed to help participants organize science teaching in depth, will cover chemistry, physics, and other sciences, with emphasis on the development of lecture demonstrations in radiation chemistry, physics, and biology, and in atomic energy. Deadline: 25 November 1961. (Science Demonstration Lecture Program, Oak Ridge Institute of Nuclear Studies, P.O. Box 17, Oak Ridge)

Scientists in the News

Hidden T. Cox, executive director of the American Institute of Biological Sciences, will serve a 6-month term as the National Aeronautics and Space Administration's assistant administrator for public affairs, effective in December. **John Olive**, AIBS deputy executive director, will serve as acting executive director of the society for the 6-month period.

Recent awards of the American Chemical Society:

Charles R. Hauser, James B. Duke professor of chemistry at Duke University, will receive the 1962 synthetic organic chemistry award.

George B. Kistiakowsky of Harvard University, former special assistant to President Eisenhower for science and technology, has won the Charles Lathrop Parsons award for outstanding public service.

Paul J. Flory, of Stanford University's chemistry department, has won the William H. Nichols medal.

Jack L. Strominger, of Washington University, is the 1962 recipient of the Paul-Lewis Laboratories award in enzyme chemistry.

William G. Chace, a research director at Air Force Cambridge Research Laboratory, will serve as advisory science editor for Plenum Press in New York, editing a forthcoming series in the field of high-energy pulse techniques.

Recent awards of the Botanical Society of America:

William R. Taylor, of the University of Michigan, and **F. C. Steward**, of Cornell, have been named merit award winners for their contributions to North American botany.

Paul B. Green, of the University of Pennsylvania, has won the annual Dabaker prize for his work in the study of algae.

Ernest D. Riggsby, professor of physical science at Troy State College (Alabama), has been appointed educational consultant to United States Steel Corporation.

Recent staff appointments at the University of Miami's Institute of Marine Science:

John H. Steele, biophysicist at the Aberdeen (Scotland) Marine Labora-

tory, will spend 1 year at the institute as visiting research assistant professor.

Robert J. Hurley, former underwater systems research oceanographer for Bell Telephone Laboratories, has been named research assistant professor.

Recent Deaths

W. S. Benedict, 73; dentist and former professor of dental radiology and oral surgery at Georgetown University; 17 Oct.

Edward R. Dye, 59; auto safety engineer at Cornell University aeronautical laboratory until 1958, when he founded the New Products Research and Development Engineering Company in New York; 14 Oct.

Harvey B. Haag, 61; former professor and chairman of the department of pharmacology at Medical College of Virginia; 14 Oct.

Paul R. Heyl, 89; retired physicist formerly with the Bureau of Standards, and consultant in physics and mathematics to various government and industrial projects connected with the war effort; co-inventor of the earth induction compass; 22 Oct.

Robert McKinney, 66; retired chemist formerly with the U.S. Department of Agriculture; 21 Oct.

Allan McLaughlin, 89; former assistant surgeon general of the U.S. Public Health Service; 20 Oct.

Koichi Muraji, 52; Japanese radiologist who conducted research on the victims of the Hiroshima and Nagasaki bombings; 13 Oct.

Gustav H. Rieman, 58; professor of genetics at the University of Wisconsin; 15 Oct.

George H. Young, 52, director of research at Mellon Institute; 10 Oct.

Erratum: In the report by A. D. McLaren and R. A. Luse on the "Mechanism of inactivation of enzyme proteins by ultraviolet light (2537 Å)" [*Science* 134, 836 (22 September 1961)], two errors occur in the values given for Φ for enzymes in the last two lines of the table. The calculated value of Φ for ribonuclease is 0.03, not 0.30. The known value of Φ for trypsin is 0.015, not 0.105.

Erratum: In the article "Radio telemetering from within the body" by R. Stuart Mackay [*Science* 134, 1196 (20 Oct. 1961)] one line was omitted and another line was printed twice in the paragraph beginning just above the middle of column 1, page 1199. The first line of the paragraph is repeated in the fourth line. The first two sentences should have read: "The permissible radio-frequency deviation is limited to the bandwidth of the receiver if loss of signal is never to occur. Receivers can record higher-deviation signals by tracking them with a standard automatic frequency-control circuit, the frequency-discriminator signal then being the useful output. (8)" (italicized words omitted).

Book Reviews

Essays Honoring Paul Radin

Culture in History. Stanley Diamond, Ed. Published for Brandeis University. Columbia University Press, New York, 1960. 1014 pp. \$15.

The opening statements penned in the contributions by Claude Lévi-Strauss and A. Irving Hallowell best express the qualitative significance of this exceedingly rich tribute to the late Paul Radin. "Among the many talents," writes Lévi-Strauss, "which make him one of the great anthropologists of our time, Paul Radin has one which gives a singular flavor to his work. He has the authentic esthetic touch, rather uncommon in our profession. This is what we call in French *flair*: the gift of singling out those facts, observations, and documents which possess an especially rich meaning, sometimes undisclosed at first, but likely to become evident as one ponders the implications woven into the material" (page 351). And Hallowell observes, "It has become increasingly apparent in recent years that the potential significance of the data collected by cultural anthropologists far transcends in interest the level of simple, objective, ethnographic description of the peoples they have studied. New perspectives have arisen; fresh interpretations of old data have been offered; investigation and analysis have been pointed in novel directions" (page 19).

A *Festschrift* that is not a symposium runs the risk of becoming a rag-bag into which authors dump their miscellaneous, hitherto unpublished articles. By a happy combination of circumstance and good editing, there is very little of this in *Culture in History*, despite the fact that 55 different authors contributed. Three unifying strands bind the many parts into a medially integrated whole. These are: (i) the application to specific field-work data, or to historically derived materials (Greek, Hebrew, and Christian), or to general

theory making, of Radin's seminal ideas relating to the intellectual and religious processes among primitive peoples; (ii) the application of new anthropological data and theory to the further explication of the culture of Radin's own Indians, the Winnebagos, among whom he did intensive field work from 1908 to 1913, and concerning which Radin published seven books or monographs and 17 articles; (iii) the editorial limitation of other articles to aspects of culture in which Radin manifested some interest (language, mythology, class stratification and political-economic organization, history, and social theory). Thus, there is but one article on archeology (and that relates to the Winnebago) and none on physical anthropology. The book falls definitely within the social sciences and humanities, and not within the physical sciences. Forty-four of the authors are anthropologists, ten are humanists, and one is a psychiatrist. A number of the articles (for example, those by Hallowell, Murra, and Mandelbaum, to name but three) are fascinating manifestations of systematic, exacting, and critical research, empirically founded and sophisticatedly enriched through the application of subtle and profound theory. Others are equally exacting historical studies in the best humanistic tradition, some vitalized with culture theory infused from anthropology. A number of the papers either directly or indirectly deal with processes of social evolution (Goldman, pages 687-712, specifically in Polynesia; Fried, pages 713-731, generally; Tillich, pages 631-641, and Moore, pages 642-662, in terms of Marxian theory), while Leslie White, the leading anthropological protagonist of social evolutionism, contents himself with a brief ethnographic summary of the Keresan Pueblo world view (pages 53-64). There are no papers on personality and culture, the topic that was so popular between 1935 and 1955. Gene Weltfish offers a new dimension to materialism as a sug-

gested unifying method for anthropological research (pages 160-180). Lenneberg argues a developmental-genetic hypothesis for the evolutionary emergence of speech in a paper that should be of general interest (pages 869-893), while the remaining six papers on linguistics, including one by Kroeber, make up the bulk of the specifically technical papers in the volume.

To return to the papers that directly relate to Radin's own contributions: James Griffin painstakingly reviews, synthesizes, and reinterprets the vast body of archeological data from the full range of the Mississippi Valley to place Winnebago prehistoric origins in a new and more firmly rooted perspective (pages 809-865). In a much briefer paper N. O. Lurie performs the same task with documentary sources for the Winnebago protohistoric era of 1620 to 1670 to show how a Siouan tribe became assimilated to an Algonkian cultural setting (pages 790-808). Lévi-Strauss unfolds the deep altruism of Winnebago ideals of heroic self-sacrifice through a fascinating structural analysis of four Winnebago myths published by Radin in 1941 (pages 351-362).

Among those who go in the other direction, approaching their own field work with a Radinian kind of orientation, are Hallowell (pages 19-52) and Kluckhohn (pages 65-98). Hallowell, in demonstrating the nature of Winnebago perceptive categories forcefully reveals anew the conceptual artificiality of our own notions of what is natural and therefore subject to scientific explanation. Kluckhohn does somewhat the same thing for the Navaho, whose cultural focus is on minute categorical definition. Redfield and Bidney re-examine two of Radin's major notions. Redfield (pages 3-18) applies Radin's theory of the primitive intellectual as the systematic unifier of tribal beliefs to an explanation of how the Dogon tribe of the French Sudan could possibly have achieved so incredibly an elaborate scheme of symbolically represented knowledge as is reported for it by the French ethnologist, Griaule. Maurice Stein, for his part, reflects on how anthropological interpretations, exemplified in the work of Radin and Redfield, may be used by other social scientists to reform modern civilization in terms more meaningful to individual livelihood (pages 281-297). David Bidney contributes a healthy neutralizer for the enthusiasts who tend to get carried away into loose generalization as they pick

up some of Radin's larger ideas. He shows (pages 363-379), in a tough-minded critique of Radin's writings on primitive monotheism and economic exploitation of religious gullibility, that Radin vacillated and reversed his thinking several times over half a century. He was not himself too certain of the objective content of some of his more stimulating ideas.

Anthropologists will all cherish this volume for its intrinsic worth. They will also sentimentally value it. Radin died shortly before the 75th birthday it was intended to celebrate, and in it are posthumously published articles by four other great men of anthropology—Kroeber, Lowie, Redfield, and Kluckhohn—who wrote to honor their friend but, like him, did not live to see the book become a reality. Nonanthropologists whose scholarly interests find enjoyment in occasional forays into fertile fields outside their own will find it to be well worth sampling.

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Tides and Currents

Physical Oceanography. Albert Defant. Pergamon, New York, 1961. vol. 1, xvi + 729 pp.; vol. 2, viii + 598 pp. Illus. + maps. \$35.

This two-volume work is a textbook about that part of physical oceanography which comprised the whole prior to 1939. Its two volumes are each divided into two parts; volume one contains material on distribution of physical and chemical properties of the oceans (part 1) and dynamical oceanography (ocean currents) (part 2). Volume 2 is devoted to surface and long waves (part 1) and to tides and tidal currents, including internal waves, (part 2).

The book is arranged as a textbook (without problems), and each new subject is introduced with a lucid, and readable, elementary description which will be most helpful to new students and experienced oceanographers alike. In the theoretical parts, mostly volume 1, part 2, and volume 2, fundamental theory is also presented clearly, and the special vocabulary of oceanography and meteorology (they are very similar) is introduced term by term, so that you are left with the feeling that you have

been led simply by the hand, and by a master.

The author is one of the older members of the group of German oceanographers who sailed the *Meteor* extensively in the North and South Atlantic between World Wars I and II. These scientists were prolific contributors to the literature produced by the larger group of European oceanographers who dominated this branch of science prior to 1930. Hence it is not surprising that Defant's references are largely to the work of German oceanographers and that his illustrative examples come mostly from the Atlantic Ocean. Nevertheless, his outlook is international in that he includes, with due credit, contributions from scientists of many nations.

The present book (published only in English) is a second revision of a manuscript (in German) originally written before and during World War II. The revisions bring it up to date, as of May 1957, in the fields of special interest to the author. Unfortunately, in other fields, such as bathymetry and optics, his material is not at all up to date, and he has not included in his summary of the structure of the ocean basins any impression of the wealth of geophysical material published during the early 1950's. The book would be a better textbook had these matters been attended to, but I am content to see the result as it is; Defant has kept abreast of his own interests, and as a result, we have an immensely valuable book.

Both descriptive and theoretical parts are profusely illustrated with examples taken from nature. Thus one is left with a feeling that difficult or abstract-sounding mathematics has been used successfully to account for the rather complex results of observation. Furthermore, when such is not the case, the author skillfully defines the shortcomings of both theory and observation.

Though he makes no commitment to do so, Defant summarizes in tables and charts the distribution, usually on a world-wide scale, of many oceanographic variables. While his summaries will scarcely satisfy a specialist, they should prove very helpful to students.

No attempt is made to describe instruments, except a few of the older types—for example, the Nansen bottle and reversing thermometer—which have a venerable history in oceanography. Instruments are an important expression of the state of understanding in any observational science, and an instrumental revolution which is complete-

ly missing in this book was underway in oceanography long before 1957. I believe this to be the book's greatest lack.

The composition is so well worked out that only rarely does one have to turn the page to consult a figure referred to in text. This is a considerable achievement which compositors often seem to try to avoid. Although the figures are generally clear, a magnifying glass is sometimes needed for identifying the coordinates of graphs. The bibliographies (at the end of each part) form an important part of the text, since Defant, in the course of a few sentences, frequently leaves the student a considerable assignment of outside reading. I am least well equipped to comment on this part of the book, since I am almost totally ignorant of European oceanographic literature. However, I hope that before future printings are made the large number of obvious editorial mistakes in the bibliographic references can be corrected. I think it likely that these errors are more characteristic of the parts of the literature I know than of the whole bibliography, but they will prove confusing and should be repaired.

I had great pleasure in reading this book, and I except to have a great deal more. It should be useful to a wide professional readership as a detailed and yet grand exposition of man's understanding, just past mid-century, of water motion of the oceans.

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Gram Determinant

The Theory of Crystal Structure Analysis. A. I. Kitaigorodskii. Translated from the Russian by David and Katherine Harker. Consultants Bureau, New York, 1961. xi + 275 pp. Illus. \$12.50.

The title of this book is a fair representation of its content. The book deals with the theoretical background useful in finding the location of atoms in a crystal, using as data a set of the absolute values of the amplitudes of the x-ray diffraction spectra. It is directed, therefore, to the crystal-structure analyst who already has a considerable background in the theoretical and practical experimental aspects of x-ray dif-

fraction by single crystals. Most readers of this review will not find themselves in this category, so I offer this much abbreviated background:

Our present-day understanding of the solid state comes fundamentally from our knowledge of the arrangements of atoms in crystals, and this is provided chiefly from studies of crystals by their diffraction of x-rays. There is a straightforward relation between the characteristics of the diffraction and the arrangement of atoms producing it, so that, if the first is known, the second can be routinely deduced. Unfortunately, the only part of the diffraction of crystals which is observable is the amplitudes of the reflections; the phases are not observable. If a crystal structure is to be deduced from diffraction data, the phases of these reflections (or their equivalent) must be supplied. This book is concerned with the theory of how to do this. For crystals having a center of symmetry the phases reduce to 0 or π , and this is equivalent to attributing a sign + or - to the amplitude of the reflection.

Fortunately, in 1947 David Harker (one of the translators of this book) and J. S. Kasper showed that relations exist between the set of diffraction amplitudes and their signs. Many contributors have added to this initial discovery, notable among them the author of this volume, Kitaigorodskii. His book is a systematic and integrated treatment of the whole subject, from his own point of view. This occupies six chapters and covers some 270 pages.

After developing the general background of the subject, the author comes, in chapter 4, to his favorite treatment, the application of the Gram determinant. This has useful properties for the problem of sign determination, because this determinant cannot be negative. From this determinant another, whose elements are the amplitudes, may be derived, which must have a value greater than, or equal to, zero. Inequalities useful in sign determination can be deduced from this. Chapter 4 really represents the core of the book, and it gives the reader an insight into the author's point of view in crystal-structure analysis.

Chapter 5 deals with the Patterson synthesis. This is treated in an illuminating analytical fashion. Nevertheless, since the subject is really concerned with geometry, the analytical treatment leaves a good deal which must be geometrically imagined.

This book is a valuable addition to the literature of crystal-structure analysis; those who work in this field will be glad to have this integrated treatment of phase determination. The translators are to be congratulated for making this difficult subject available in easily read English. The printing is by photography from typescript, so that there are places where the equations appear a little awkward and a few other places where the typescript appears to have been smudged.

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Climates of the Past

Descriptive Palaeoclimatology. A. E. M.

Nairn, Ed. Interscience, New York, 1961. xi + 380 pp. Illus. \$11.

The contents of this important volume include an essay on the scope of paleoclimatology (by Nairn, who is also the editor), an article on the fundamentals of climate (by H. H. Lamb), eight articles (by G. Y. Craig, R. F. Flint, Robert Green, R. Kräusel, Nairn, N. D. Opdyke, A. S. Roemer, N. Thorley, and F. B. Van Houten) appraising the various kinds of evidence (desert sandstones, evaporites, evidences of cold climates, geophysics, vertebrates, invertebrates, and plants) that can be used in attempting paleoclimatological interpretations, and four articles (by E. D. Gill, L. C. King, T. Kobayashi and T. Shikama, and M. Schwarzbach) on the sequence and kinds of past climates for various areas.

The volume is well documented and has a list of references for each article (in all there are nearly 1250 references). These will be of immeasurable value as guides to more detailed information, while the appraisals will be significant guides for future studies.

Nairn unsuccessfully attempts to establish and maintain an attitude of critical and impartial evaluation of all possible evidence and interpretations. In the interpretive section the consideration of the southern continents and India under the Gondwanaland concept, and the unit treatment accorded North America and Europe, introduce, in the first case, a bias towards continental drift, and in the second, a bias towards permanency of relative position.

With respect to the controversy over

the permanency of the continents and ocean basins, four articles favor "drift," two are opposed, and two favor "polar wandering." A truly impartial attitude is maintained in only five of the articles.

The article on the fundamentals of climate is well written and is a "must" for one who desires to consider the causes and effects of past climates. However, in view of the controversy over "continental drift," it would appear that an examination of the probable changes in atmospheric and oceanic circulation resulting from the "drift" and "polar wandering" concepts would have been a profitable addition. No matter what his philosophy, each reader will disagree with some of the contributions describing the paleoclimates of different parts of the earth, for each author represents a different viewpoint.

One final comment: the title of the volume is *Descriptive Palaeoclimatology*. In my opinion only the last four contributions, occupying just slightly over one-fourth of the book, fit the title. A simple "Palaeoclimatology" would have been better.

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Aircraft Materials

Metallic Fatigue. W. J. Harris. Pergamon, New York, 1961. xi + 331 pp. Illus. \$12.50.

This is an excellent engineering review of fatigue in commercial metals and alloys with very special emphasis on aircraft materials. The author borrows very heavily from his experiences at the de Havilland Aircraft Company of Great Britain, as evidenced by the fact that by far the majority of data quoted and illustrated appear to have originated from the de Havilland laboratories.

The author covers, in a lucid manner, the problems of stress concentration in fatigue and considers the various ways of improving the fatigue life, such as by shot peening, tensile prestretching, and other novel techniques. A special chapter is devoted to the role of frequency on fatigue. The role of corrosion on fatigue is briefly covered, and a well-documented chapter is devoted to fretting ("rubbing") fatigue.

Crack propagation and the philosophy of "safe-life" and "fail-safe" design are

covered in a special chapter. A short section is devoted to the statistical nature of fatigue. A 50-page chapter deals with a description of some current standard aircraft processes and their relation to fatigue life.

All in all, the book appears well written and the figures are well illustrated and clearly documented. The author has written from the viewpoint that the reader already knows about the elementary aspects of fatigue, and therefore the book would not be well suited for the "uninitiated" researcher or student. Extensive references are listed at the end of each chapter and seem to be complete up to the year 1956. Very few papers are quoted beyond that year.

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New Books

Biological and Medical Sciences

The Cell. Biochemistry, physiology, morphology, vol. 2, *Cells and Their Component Parts*. Jean Brachet and Alfred E. Mirsky, Eds. Academic Press, New York, 1961. 929 pp. Illus. \$25.

Electrophysiological Methods in Biological Research. J. Bures, M. Petran, and J. Zachar, Eds. Publishing House of the Czechoslovak Acad. of Sciences, Prague; Academic Press, New York, 1960. 515 pp. Illus. \$15.

Etudes d'endocrinologie. pt. 1, *Les gonadotropines*; pt. 2, *Rapports entre le complexe hypothalamo-hypophysaire et la fonction adrénocorticotrope*. Hermann, Paris, 1961. 350 pp. Illus. Séminaires 1960 de la chaire de morphologie expérimentale et endocrinologie du Collège de France dirigés par le Professeur Robert Courrier.

Fish as Food. vol. 1, *Production, Biochemistry, and Microbiology*. Georg Borgstrom, Ed. Academic Press, New York, 1961. 741 pp. Illus. \$24.

General

Anatomy of the Future. Roderick Siedenberg. Univ. of North Carolina Press, Chapel Hill, 1961. 173 pp. \$3.50.

Darwinism and the Study of Society. A centenary symposium. Michael Banton, Ed. Tavistock, London; Quadrangle Books, Chicago, Ill., 1961. 211 pp. \$5. Contributions by Michael Banton, S. A. Barnett, Tom Burns, B. Farrington, Morris Ginsbert, Lancelot Hogben, George Shepper-son, J. Maynard Smith, W. Stark, C. H. Waddington, and Basil Willey.

Educators Guide to Free Films. Mary Foley Horkheimer and John W. Diffor, Eds. Educators Progress Service, Randolph, Wis. ed. 21, 1961. 646 pp. \$9.

Essay on Atomism. From Democritus to 1960. Lancelot Law Whyte. Wesleyan

Univ. Press, Middletown, Conn., 1961. 108 pp. \$2.95.

Fabric of Freedom 1763-1800. Esmond Wright. Hill and Wang, New York, 1961. 311 pp. \$4.50.

Growing Old. The process of disengagement. Elaine Cumming and William E. Henry. Basic Books, New York, 1961. 309 pp. \$6.75.

Management Games. A new technique for executive development. Joel M. Kibbee, Clifford J. Craft, and Burt Nanus. Reinhold, New York; Chapman and Hall, London, 1961. 359 pp. Illus. \$10.

Marriage and the Family. Alfred McCullung Lee and Elizabeth Briant Lee. Barnes and Noble, New York, 1961. 396 pp. Paper, \$2.25.

Michael Faraday. A list of his lectures and published writings. Alan E. Jeffreys. Published for the Royal Institution of Great Britain. Academic Press, New York; Chapman and Hall, London, 1960. 114 pp. Illus.

The Mystery of Life. Arnold M. Ludwig. Thomas, Springfield, Ill., 1961. 158 pp. \$5.75.

Mythologies of the Ancient World. Samuel Noah Kramer, Ed. Quadrangle Books, Chicago, Ill., 1961. 480 pp. \$7.50.

The Nature of Genius. Andrew Gemant. Thomas, Springfield, Ill., 1961. 216 pp. \$6.50.

Nuclear Physics in Peace and War. Peter E. Hodgson. Hawthorn, New York, 1961. 156 pp. \$3.50.

A Patent Manual for Scientists and Engineers. George M. Naimark. Thomas, Springfield, Ill., 1961. 123 pp. \$5.50.

Patients' Views of Medical Practice. Eliot Freidson. Russell Sage Foundation, New York, 1961. 268 pp. Illus. \$3.75.

Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960. Rubber Research of Malaya, Kuala Lumpur, Selangor, Federation of Malaya, 1961. 1015 pp. Illus.

A Report to the National Academy of Sciences-National Research Council from the USA National Committee of the International Scientific Radio Union. On the 13th General Assembly, 5-15 September 1960, London, England. Publ. 880. John P. Hagen, Ed. Natl. Acad. of Sciences-Natl. Research Council, Washington, D.C., 1961. 595 pp. Illus. \$5. Discussion of the status and problems of radio science.

The Slow Learner in the Classroom. Newell C. Kephart. Merrill Books, Columbus, Ohio, 1960. 303 pp. Illus. + plate.

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Reports

Use of Fat-Soluble Fluorescent Brighteners on Microorganisms

Abstract. We have applied a fat-soluble fluorescent aid to certain microorganisms. The aid, a stilbyl triazole compound, fluoresced more in the presence of certain strains of flocculating brewing yeasts than in the presence of nonflocculating types. The work suggested the possibility that flocculating yeasts may possess more surface lipids than the nonflocculating organisms. The performance of the compound on rapidly growing cell centers and bacterial spores is described, and the possible application of the technique to other areas of microbiology is outlined.

Very few references are available on the application of fluorescent compounds in visual studies of lipids on microorganisms. Bekker and Tasman in 1942 (1) and Mankiewicz in 1952 (2) studied the use of auramine O dye in the visualization of lipids or waxes of *Mycobacterium*. The extraction of such organisms with fat solvents caused loss of auramine O fluorescence and, at the same time, loss of acid-fastness. Unlike O, the fat-soluble stilbyl triazole substances are extremely hydrophobic. The compound used in the present work was 2-(stilbyl-4'')-(naphtho-1',2':4,5)-1,2,3-triazole-2''-sulfonic acid *n*-octylamide (STC) (3).

Darken (4) reported on the successful use of more polar type substances of the diaminostilbene class. As applied to yeasts and other microorganisms, her compound fluoresced more strongly in

active growing centers and was transferred by growing cells to their offspring. However, the brighteners used by Darken were substantive to protein or cellulose, whereas the substance used in the present work was found to be specific for lipids rather than for proteins, carbohydrates, or yeast nucleic acid.

A typical experiment in which STC was applied to flocculating (class III) and nonflocculating (class I) Guilloiland brewing yeasts (5) is described below. In this procedure the cells were grown in Wickerham's YM broth, made by rehydrating 3 g of Difco yeast extract, 3 g of Difco malt extract, 5 g of Difco peptone, and 10 g of glucose per liter of medium. Yeasts were washed free of medium with 0.001M phthalate buffer at pH 3.8 and resuspended in 10-percent buffered glucose at 26°C, glucose being added as a dispersant for the flocculated class III cells. The suspension was adjusted to an optical density of 1.30 at 610 m μ in a Coleman universal spectrophotometer. To 9.0 ml of suspension was added exactly 1.0 ml of STC solution (10 mg of STC per 100 ml of fat-free acetone diluted with three parts of distilled water). The mixture was shaken for 10 minutes at 90 to 100 cy/min; the cells were centrifuged and washed three times with buffer. Fluorescence readings were taken on a model 12B Coleman photofluorometer with primary filter No. 12,221, which does not pass radiation above 365 m μ , and secondary filter 12,222, which passes radiation above 400 m μ . The primary filter was five-sevenths masked to reduce the amount of radiation applied to the suspensions, and the instrument was operated at maximum sensitivity. The fluorescent standard was aqueous quinine sulphate at 1.0 μ g/ml adjusted to pH 1.0 with concentrated H₂SO₄, and this gave a reading of 100 with the above setting. Class I cells gave readings of about 10

percent fluorescence, while class III cells gave readings of about 100 percent fluorescence. Without STC the readings for both classes were 0. The flocculent cells consistently gave greater fluorescence, which suggested larger amounts of lipids on their surfaces.

The fluorescence of yeast cells after treatment with and centrifugation from 2.50 μ g of STC per milliliter of suspension was observed through an ultraviolet microscope. The ultraviolet source was a 200-watt mercury arc lamp (6). The exciter filter was Corning No. 5840, and this was protected by heat-absorbing glass. A Wratten 2B barrier filter was placed in the microscope eyepiece. Mature cells exhibited fluorescence on the surface. In contrast with these older cells, the buds and particularly their bases demonstrated much greater fluorescence. In a similar manner, the spores of *Bacillus coagulans* 6125 (7) gave greater fluorescence than did vegetative cells.

At present it is not possible to say whether STC is actually absorbed by rapidly growing cell centers or whether it is simply adsorbed on the surface of these centers and becomes more fluorescent owing to higher concentrations of fat-like compounds present there. Experiments are in progress to determine whether the uptake of STC follows any of the classical adsorption laws. It is possible the fat-soluble stilbyl-type brighteners could answer questions in growth and reproduction that the more polar types could not. The fat-soluble optical brighteners should be tried in the study of different classes of cell membranes, as well as in the study of fat metabolism. Experience indicates that a general technique could be developed with STC for detecting traces of adsorbed fatty acids on yeasts and other organisms which might have value in following assimilation or excretion of lipids by a wide range of cell types.

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5 July 1961

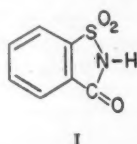
Correlation of Chemical Structure and Taste in the Saccharin Series

Abstract. Results of experiments with approximately 80 saccharin derivatives show that substitution in the number 2 or 3 position gives tasteless compounds. Substitution in the benzene ring of saccharin with the electron-withdrawing nitro group gives a bitter tasting substance. Substitution with an electron-donating group results in a sweet taste. Perhaps a "lock and key" fit at a receptor site is necessary for taste.

Many attempts have been made to explain the tastes of substances in terms of their chemical structures. Although limited correlations have been found, no unifying generalizations have been possible (1).

Unlike the salt and sour tastes, the sweet and bitter are not confined to single chemical groups, but are found in practically every class of compounds. Finzi and Colonna (2), after a critical survey of the correlation of chemical structure and taste, concluded that it was impossible to derive any law for aromatic compounds and that sweet taste depends not on any single factor, such as a certain taste-producing group, but on the entire chemical complex of the particular compound studied.

One of the better-known sweetening agents is saccharin (I), discovered in 1879 by Remsen and Fahlberg (3). Many compounds related to saccharin have been prepared in the intervening years. Cohn (4) summarized some of this information by concluding that the



sweet taste is lost if the sulfimide ring is opened, or if the imide hydrogen is replaced; and that substitution in the benzene nucleus reduces the sweet, and introduces a bitter taste.

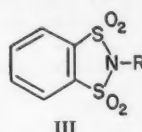
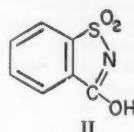
This study reports the taste, and any possible correlations with chemical structure, of approximately 80 saccharin derivatives. The saccharin derivatives were tasted, and the particular taste recorded, usually simply as being present or absent. The results (for about 60 compounds) are shown in Table 1. Some generalizations that may be drawn from these results are given below.

Replacement of the imide hydrogen with another chemical group gave, in almost every case, a tasteless compound. Both sweet and bitter substances were converted to tasteless substances by this

substitution in the 2-position. The only apparent exceptions were three compounds in Table 1 (Nos. 34 to 36). Here, the bitter taste may be the result of the contribution of the basicity of the relatively high molecular-weight tertiary amino group. These results seem to lend evidence to the belief that the sweet taste is attributable to the anion (5). Or, perhaps the sense of taste resembles other types of physiological responses, and is subject to the "lock and key" concept of biological activity (6). Substitution on the imide nitrogen, then may affect the specific molecular shape which must fit the receptor site. Thus, these 2-substituted compounds then are not complementary to the taste receptors, and display no taste. However, some workers have reported 2-substituted saccharins which do not ionize or hydrolyze, yet have a sweet taste (7).

Another possible explanation for the

lack of taste of the 2-substituted saccharins may be that isomerization of the lactam form to the lactim form (II) is necessary for sweet (and bitter) taste. Substitution in the 2-position destroys the possibility of formation of this lactim form. The group $=C=N$, which is present in the lactim form, imparts a bitter or burning taste (8).



In *o*-benzenedisulfonimide, the replacement of the imide hydrogen by an alkyl group (III) changes the taste from sweet with a bitter after-component, to practically tasteless. This effect is analogous to the results of 2-substitution in saccharin.

Table 1. Taste of saccharin derivatives. Abbreviations: S., Sweet; B., bitter; none, tasteless; Slt., slightly; Mod., moderately.

Compound No.	Y	R	Taste	Compound No.	Y	R	Taste
				36	H	$CH_2CH_2CH_2N$ (C_6H_5) ₃	Mod. B.
1	4-NO ₂	H	Slt. S. (not B.)	37	H	COOC ₆ H ₅	None
2	5-NO ₂	H	Mod. B. (not S.)	38	H	CON(C ₆ H ₅) ₃	None
3	6-NO ₂	H	Slt. S., then very B.	39	H	CSN(C ₆ H ₅) ₃	None
4	7-NO ₂	H	Mod. B. (not S.)	40	H	CH ₂ -2-saccharin	None
5	4-NH ₂	H	S.	41	H	(CH ₂) ₂ -2-saccharin	None
6	5-NH ₂	H	None	42	H	(CH ₂) ₃ -2-saccharin	None
7	4-NHC OCH ₃	H	None	43	H	(CH ₂) ₄ -2-saccharin	None
8	5-NHC OCH ₃	H	None	44	H	(CH ₂) ₅ -2-saccharin	None
9	6-SO ₂ NH ₂	H	Slt. sweet- astringent	45	H	(CH ₂) ₁₀ -2-saccharin	None
10	4-NO ₂	C ₆ H ₅	None	46	H	CH(C ₆ H ₅)CH ₂ -2-saccharin	None
11	4-NO ₂	<i>n</i> -C ₆ H ₇	None	47	H	(CH ₂) ₂ NCH ₃	None
12	4-NO ₂	SCCl ₃	None			(CH ₂) ₂ -2-saccharin	
13	5-NO ₂	CH ₃	None				
14	5-NO ₂	C ₆ H ₅	None	48	H	N(C ₆ H ₅) ₂	None
15	6-NO ₂	C ₆ H ₅	None	49	NO ₂	N(C ₆ H ₅) ₂	Slt. B.
16	6-NO ₂	<i>n</i> -C ₆ H ₇	None	50	H	OCH(CH ₃) ₂	None
17	6-NO ₂	<i>i</i> -C ₆ H ₇	Mod. B.				
18	6-NO ₂	<i>n</i> -C ₆ H ₉	Mod. B.				
19	6-NO ₂	CH ₂ CH=CH ₂	Slt. B.				
20	6-NO ₂	<i>n</i> -C ₆ H ₁₁	Slt. B.				
21	6-NO ₂	SCCl ₃	Slt. B.				
22	6-NH ₂	C ₆ H ₅	None				
23	6-NH ₂	<i>n</i> -C ₆ H ₁₁	None				
24	6-SO ₂ NH ₂	CH ₃	Slt. B.				
25	6-SO ₂ NH ₂	<i>n</i> -C ₆ H ₇	None				
26	H	CH ₃	None	51	H	H	S., B. after-taste
27	H	C ₆ H ₅	None	52	H	CH ₃	None
28	H	<i>n</i> -C ₆ H ₇	None	53	H	C ₆ H ₅	None
29	H	<i>i</i> -C ₆ H ₇	None	54	H	<i>n</i> -C ₆ H ₇	None
30	H	CH ₂ CH=CH ₂	None	55	H	<i>n</i> -C ₆ H ₉	None
31	H	<i>n</i> -C ₆ H ₁₁	None	56	H	(CH ₂) ₂ N (C ₆ H ₅) ₂	Slt. B.
32	H	cyclo-C ₆ H ₅	None	57	H	(CH ₂) ₃ N (C ₆ H ₅) ₂	Slt. B.
33	H	CH ₂ CH ₂ N (CH ₃) ₂	Slt. numbing	58	H	(CH ₂) ₃ N (C ₆ H ₅) ₂	Slt. B.
34	H	CH ₂ CH ₂ N (C ₆ H ₅) ₂	Mod. B.				
35	H	CH ₂ CH ₂ N (<i>n</i> -C ₆ H ₉) ₂	Mod. B.				

Inspection of compounds 1 through 9 in Table 1 in general shows that substitution in the benzene ring has a tendency to emphasize the bitter component in the taste. This is especially true with an electron-withdrawing group such as the nitro group. For example, 6-nitrosaccharin has a slightly sweet first taste and then an extremely bitter after-taste. Noyes (9) has shown that reduction of the nitro to the electron-donating amino group in 6-aminosaccharin results in a sweet-tasting compound. According to Finzi and Colonna (2), conversion to the 6-acetamidodisaccharin gives a tasteless compound. My results with the 4-, 5-, and 7-nitrosaccharins, which are somewhat comparable, show them to be either slightly sweet or moderately bitter in taste. The 4- and 5-aminosaccharins are quite sweet and tasteless, respectively. The 4- and 5-acetamidodisaccharins are tasteless.

In addition to the inductive effect of a group attached to the ring on taste, resonance may play a part in taste. The 4- and 6-nitrosaccharins, which are ortho and para, respectively, to the carbonyl group, have slightly sweet components to the taste. The 5- and 7-nitrosaccharins, which are meta to the carbonyl group, have no sweet components and show only the bitter taste. The ortho and para substituted 4- and 6-aminosaccharins are quite sweet, while the meta substituted 5-aminosaccharin is tasteless. Perhaps the resonance contributions of these groups to the relative acidity of the molecule, or to the relative ease of formation of the lactim form, is responsible for the differences in taste of the above saccharin derivatives.

Substitution in the 3-position has the same effect as substitution in the 2-position; tasteless compounds are produced (Nos. 48 to 50 in Table 1).

As previously reported (5), opening of the heterocyclic ring destroys the sweet (and bitter) taste (compounds not included in Table 1).

It is interesting to note that doubling the saccharin molecule results in lack of taste (Table 1, Nos. 40 to 47).

It will be noticed that many of these saccharin derivatives have a bitter taste. Indeed saccharin itself has a bitter after-taste (10). It then appears that the bitter taste is widespread in saccharin-like compounds. Thus, the saccharin moiety may basically possess a bitter taste component.

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12 December 1960

Recent Change in the Pattern of Tree Growth in Northern Arizona

Abstract. A significant change in growth pattern among the ponderosa pines (*Pinus ponderosa* Laws.) of the Flagstaff region, northern Arizona, occurred in 1947-1948. This is the first such change since 1904-1905. Evidence appears to verify the existence of a tension zone which fluctuates in altitude as a result of changes in the distribution and quantity of the rainfall as recorded through soil moisture.

Recent reports (1) of glacier advances during 1948-1949 in Washington and during 1950-1954 in British Columbia suggest the importance of a change in the pattern of tree growth at the same time in northern Arizona.

Field work in the American Southwest has revealed (2) three definite growth patterns associated with three

rainfall or soil moisture types. A predominantly winter rainy season characterizes the Central California, or Sierra, type, and the pattern consists of growth layers which are rather uniform in thickness, single within the annual increment, and entire around the circuit of the trunk.

Under the West Texas type, rainfall occurs chiefly during the long summer season, and the West Texas pattern consists of growth layers of great variability in thickness, of much lenticularity, and of multiplicity within the annual increment.

The Northern Arizona type has a double rainy season, one in winter and one in summer, which promotes, in general, two intervals of major soil-moisture replenishment and two of depletion. The Northern Arizona pattern consists of a combination of the other two patterns: a sequence of growth layers characterized by the uniformity and simplicity of the Central California pattern alternates with a sequence characterized by the variability and complexity of the West Texas pattern.

Studies of soil moisture and rainfall, temperature, length of growing season, growth-layer anatomy (3), and daily growth have given strong support to two earlier concepts concerning the causes of the Northern Arizona pattern. First, the West Texas rainfall type and growth pattern apparently extend westward at low elevations, whereas the Central California type and pattern extend eastward at high elevations. At the contact in northern Arizona a tension zone is set up, and it is in this zone

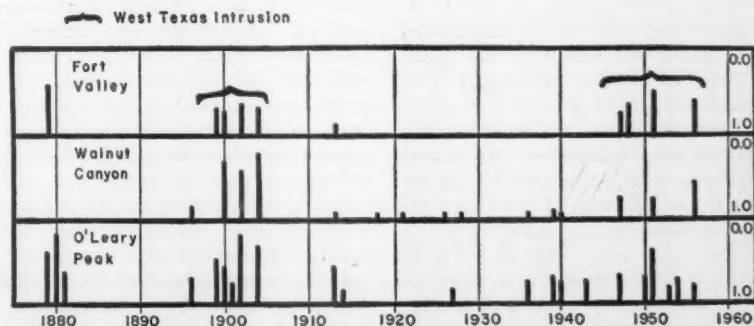


Fig. 1. Migration of the tension zone in the ponderosa pine forest of northern Arizona. Height of lines indicates degree of variability and lenticularity based on a qualitative ratio scale. The plot for Fort Valley includes 32 trees from Fort Valley high in the tension zone, 7300 to 7500 ft elevation, 6 to 7 miles southwest of the San Francisco Peaks; the plot for Walnut Canyon includes 14 trees from Walnut Canyon National Monument, low in the tension zone, 6800 to 6900 ft elevation, some 17 miles southeast of the San Francisco Peaks; and the plot for O'Leary Peak includes 41 trees near O'Leary Peak at the lowest edge of the tension zone, 7150 to 7300 ft elevation, some 6 to 7 miles northeast of the San Francisco Peaks.

that the Northern Arizona pattern exists. Second, the fluctuations of the tension zone depend upon a change in the distribution and quantity of rainfall as transmitted through soil moisture. Upward penetration of the West Texas type and downward migration of the Central California type produce the alternation of conditions yielding the Northern Arizona pattern.

The last major intrusion upward of the West Texas type and pattern ended in 1904–1905. It was realized in 1946 that the tension zone had been dominated for 40 years by the Central California pattern and that this period was one of the longest, if not the longest, during the last few centuries. A long-range program was begun: 12 permanent stations were established in the vicinity of Flagstaff and, except for 1948, increment cores were taken annually from some 70 to 90 trees. We hoped to observe actual migration of the tension zone. Later study proved that our collections span such a period of migration.

A major change in pattern apparently began in 1947–1948 among the trees in the heart of the tension zone. During the past year a thorough study of all cores has emphasized the intensity of the upward intrusion of the West Texas type. Figure 1 shows the alternation of growth patterns: West Texas, 1899–1904; Central California, 1905–1946; and West Texas, 1947–1956. In addition to variability the figure shows lenticularity, which is characteristic of the growth layers for 1899, 1900, 1902, 1904, 1947, 1951, and 1956.

The upward intrusion since 1947 of the West Texas pattern, caused by a shifting rainfall regime, appears to be a major migration and, in conjunction with glacier advances (1), may reveal evidence of a widespread climatic fluctuation.

Future collections will reveal whether the intrusion has ended or will continue over a span of years approaching the length and intensity of intrusions recorded during recent centuries (4).

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Interocular Transfer of Pattern Discrimination without Prior Binocular Experience

Abstract. Interocular transfer of a learned, differential pattern discrimination, as measured by an avoidance response, occurs in the goldfish. Since the stimuli, both during training and testing, were always presented in the lateral or caudal visual field, the parts of a retina involved could not have participated in prior, binocular experience.

There is as yet no sure answer to the perplexing problem of how the central nervous system is capable of responding appropriately to the relative configuration of a stimulus without regard to variations in its detailed, sensory characteristics. Interest in this problem continues to prompt numerous studies of interocular transfer in a wide range of species, including mammals, fish, and invertebrates (for example, see 1 and 2). The relevance of interocular transfer for this problem area lies in the fact that when an organism learns a visual problem exclusively with one eye and then performs it, *de novo*, with the sole guidance of the other eye, the nervous system is clearly demonstrating its ability to respond correctly to a given stimulus even though the specific afferent characteristics of the related sensory input have been dramatically altered (namely, during the transfer test, the sensory input is arriving centrally by way of a different afferent pathway).

Hebb, in his scholarly effort to explain this phenomenon and related problems (3), suggested that early, binocular, perceptual experience is re-

sponsible for developing such binocular equivalence in the related neural centers.

The present study affords a test of Hebb's suggestion, since training and test stimuli can be presented to the fish in such a way that only monocular retina is involved in either eye.

The behavioral apparatus consisted of a clear plastic starting box and goal box of identical construction, suspended from two rails in a test aquarium. Suitable electric connections allow shock to be introduced into the water inside either box. When the positive stimulus is presented monocularly, the fish has 10 seconds to swim forward from the starting box to the goal box, thus avoiding shock. When the neutral stimulus is presented, the fish must learn to remain stationary in the starting box, or else shock is administered in the anterior goal box. After the fish moves to the goal box, either correctly or incorrectly, the starting box is lifted from the water and the goal box (with the fish inside) is slid back into the starting position. The original starting box is then placed in front of the fish where it then becomes the goal box for the next trial. The fish were trained through one eye to a criterion of nine out of ten correct trials and then immediately tested for the differential response through the opposite "naive" eye. Further details of the training and testing, as well as an illustration of the apparatus used, in a series of experiments that involved the same procedure have already been reported (2). Also included in this previous report is a description of a control procedure demonstrating that there are no reflections within the test aquarium that permit the contralateral eye to view the stimuli.

The two stimuli (Fig. 1) were attached to the end of separate, thin, transparent rods so that they could be presented to the fish by being gently bobbed in front of one or the other eye. Whether the stimuli were being presented to the one eye during training or the contralateral eye during the test for transfer, the patterns were always presented either in the lateral or caudolateral part of the monocular visual field. (It should be mentioned that the goldfish is not capable of making sufficiently large eye movements to enable binocular retina to be directed laterally.) In other words, the stimuli were consistently presented in a way that involved only that portion of either retina that could never have participated

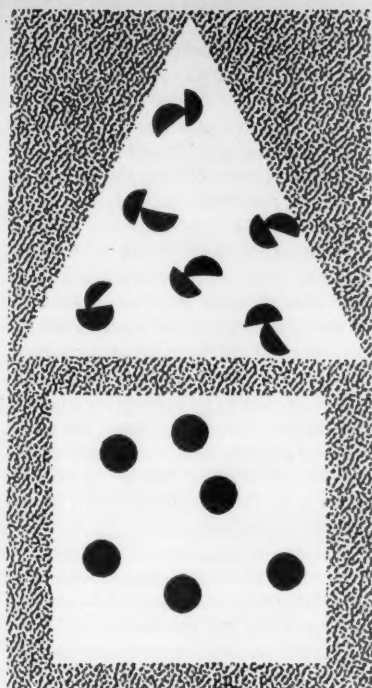


Fig. 1. Two stimuli used in avoidance training and test for interocular transfer. The square stimulus was 1.5 in. high.

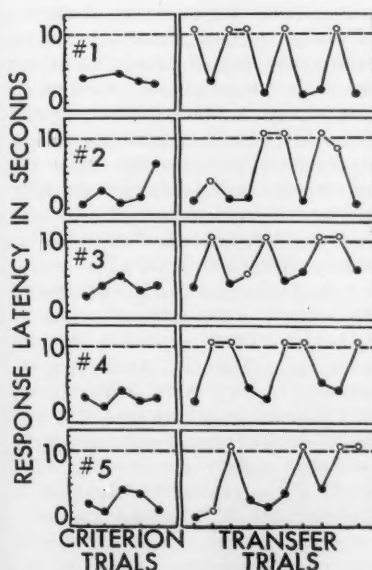


Fig. 2. Avoidance response latencies of five fish during criterion trials for "trained" eye (shown for positive stimulus only) and during test of the contralateral "naive" eye for interocular transfer. Solid circles, responses to positive stimulus; open circles, responses to neutral stimulus. With a 10-second limit on each trial, points above the dashed line represent the absence of a response.

in binocular vision. In order to preclude the possibility of a brightness discrimination, the two stimuli were constructed so that both contained the same amounts of black and white. Three of the five fish were trained with the triangular pattern as positive; the square stimulus was positive for the remaining two. Previous experience with pattern discrimination in fish suggests that the small, black dots and half-dots contributed the important differential characteristic to the stimuli.

The results are shown in Fig. 2. Quite clearly, interocular transfer of a pattern discrimination is immediately present when the naive eye is tested. Considering all five fish together, there were 25 positive trials and 25 neutral trials. In these 50 trials, there were only four occasions when a fish responded incorrectly, always by responding inappropriately to the neutral stimulus.

As far as this simple vertebrate animal is concerned, the results clearly demonstrate that prior binocular experience is not a necessary prerequisite for successful interocular transfer. However, Hebb's concern was with the proposed importance of past perceptual experience for the development of neocortical neural circuits (that is, cell assemblies). The fish has no neocortex. It could still be, for animals with neocortex, that prior perceptual experience does indeed play either a crucial or ancillary role in shaping adult perceptual abilities. There are a number of quite convincing experiments (4) to suggest that this is the case. On the other hand, an alternative interpretation of the results of these experiments is possible (2).

There are already numerous ethological studies showing that the vertebrate nervous system is innately capable of responding appropriately to the relative configuration of a stimulus. Further, recent electrophysiological findings also indicate that the adult nervous system, as far peripheral as the retina, is able to respond differentially to the configurational aspects of a stimulus (5). The present results demonstrate that this innate characteristic of the nervous system is also at work when an organism has learned a new response to a new stimulus (6).

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5 June 1961

Radar Observation of Venus

Abstract. Radar observations of Venus during the last close approach have resulted in a value of solar parallax of 8.79460 seconds of arc, corresponding to a value for the astronomical unit of 149,596,000 km. This is in satisfactory agreement with the determinations made, during the same close approach of Venus, at the Millstone Hill Radar Observatory and at Jodrell Bank, which are 149,597,700 km and 149,601,000 km, respectively. The size of the astronomical unit heretofore generally accepted as most authoritative is based upon a 1950 determination by Rabe, and is 149,532,200 km.

The R.C.A. BMEWS pulsed tracking radar system at Moorestown, New Jersey, was employed during the last close approach of Venus in an attempt to measure the size of the astronomical unit. The radar is provided with an antenna 84 feet in diameter; other parameters of the system cannot be stated here because of security classification.

Transmission periods alternated with reception periods, the transmission period in each case being several seconds less than the expected signal travel time to Venus and return, and the reception period being several seconds greater. The target was expected to introduce random depolarization of the signal, so reception was accomplished separately for both vertical and horizontal polarization, the separate wave forms being added after square law detection.

The processing of the received wave form was accomplished by analog methods up to the addition of the two detected wave forms and was then converted to digital form. In processing the data, account was taken of the

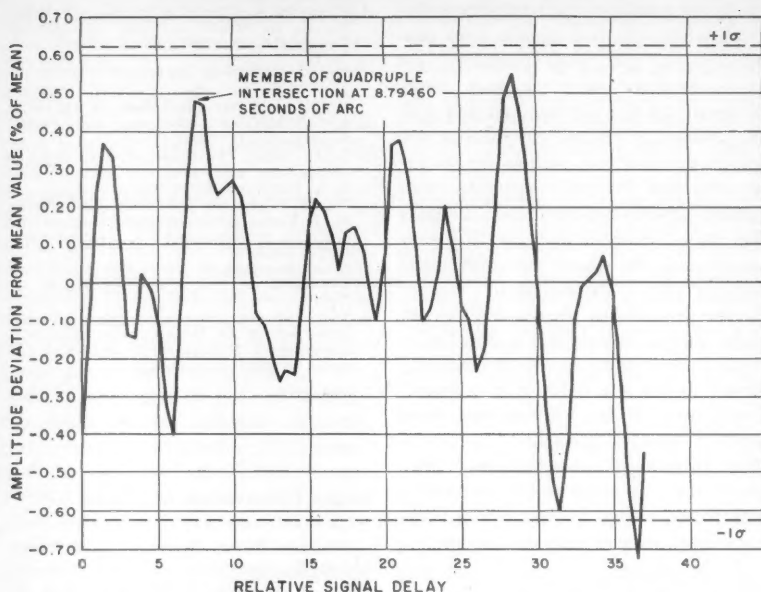


Fig. 1. Integrated data from 0.53 hour of transmission on 8 April 1961.

gradual change in range and of the effect of the rate of change of range upon the signal. The magnitudes of these effects were computed from the heliocentric spherical coordinates of the Earth and Venus as derived from the tabulations of the *American Ephemeris and Nautical Almanac* for 1961. The distance of the radar from the center of the earth, the diurnal rotation of the earth, and the finite velocity of light were taken into account in determining the best estimates of the astronomically predicted ranges and range rates for the times of the experiment.

The interpulse period employed was less than the time required for the electromagnetic energy from the radar to traverse the region of space which, from a priori position information, was expected to encompass the true location of the reflecting surface of Venus. It was originally planned to counter the resultant range ambiguity by employing a pseudorandom pulse code (as in 1). A statistical analysis of the predicted performance of the system indicated that satisfactory results could be expected from this approach for observations of at least 2 hours duration (that is, 1 hour of transmission and 1 hour of reception). Unfortunately, an extremely high local noise environment reduced the efficacy of the coded transmission method below the point of usefulness and another method was em-

ployed to resolve the range ambiguity. This was accomplished by taking advantage of the fact that the change in the range of Venus from experiment to experiment causes all the possible ambiguous range values that result from an uncoded transmission to intersect only at the true radar range. To make use of this characteristic, the detected wave form resulting from each (nominally, 2-hour) observation was integrated over a single interpulse period (applying corrections for the slow variation of the period due to the relative motion of Venus), and the four most likely locations for the return energy were selected in accordance with the four highest peaks of the resultant integration. (The expected height of a peak corresponding to signal was approximately one-half the standard deviation of the noise amplitude. See Fig. 1.) The various possible values of solar parallax in the range 8.79250 to 8.80350 seconds of arc were computed for each of the four highest peaks obtained from a total of eight observations amounting to 6.18 hours of transmitted signals. This range of values encompasses the various determinations of solar parallax made since 1950 (including the 1961 U.S.S.R. determination reported in the press).

There were a number of intersections of values from three observations, as was to be expected, since the probability

of a triple intersection due to noise alone is about 0.44. However, the results from four of the eight observations intersected at a common value of solar parallax at only one point (within the precision of the radar system, which is ± 0.00001 seconds of arc of solar parallax). The common intersection occurred at 8.79460 ± 0.00001 seconds, which is therefore taken to be the value of solar parallax determined by the experiment. The probability that this fourfold intersection out of eight observations resulted from noise alone is 0.0736, while the probability that the intersection resulted from signal is 0.913. Thus, the likelihood that the observation is a valid one is 12.4 times as great as the likelihood that the observation is invalid.

The size of the astronomical unit corresponding to this measured value of solar parallax, assuming the adopted value of 6378.388 km for the radius of the earth, is $149,596,000 \pm 200$ km, where the limits define the precision of the measurement. This is in satisfactory agreement with the determinations made, during the same close approach of Venus, at the Millstone Hill Radar Observatory and at Jodrell Bank. These measurements, converted to values of the astronomical unit by utilizing the adopted value of the earth's radius, are $149,597,700 \pm 1400$ km and $149,601,000 \pm 5000$ km, respectively (2), where the limits are indicative of accuracy, not precision. The size of the astronomical unit heretofore generally accepted as most authoritative is based upon a 1950 determination by Rabe, and is $149,532,200 \pm 6600$ km.

The observations that contributed to the fourfold intersection of values at 8.79460 ± 0.00001 seconds of arc were made on 21 March, 7 April (two experiments), and 8 April, and consisted of 3.34 hours of data in total. The target reflectivity (ratio of scattered energy to incident energy) corresponding to the results of the 21 March observation is approximately 0.26. Similar computations were not practical in the case of the other observations because of the nature of the local noise.

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18 September 1961

On the Site of Action of Amethopterin

Abstract. In the liver of the intact mouse, the conversion of exogenous folic acid to compounds with citrovorum-factor activity is inhibited completely by an amount of amethopterin similar to that bound to the enzyme folic acid reductase in vitro. Because this amount of amethopterin is several thousand times smaller than the LD_{50} , the toxic effects produced by the larger doses must be mediated via some additional mechanism.

Both folic and folinic (5-formyl-5,6,7,8-tetrahydrofolic) acids can protect mice from aminopterin toxicity (1). While folinic acid is effective when given simultaneously or even after the drug, folic acid must be given about 1 hour before aminopterin in order to provide any protection. During the period of 1 hour after the administration of folic acid, the folic acid is converted to compounds with citrovorum-factor activity, which can then serve to protect against aminopterin (2). A priming dose (nontoxic) of aminopterin abolishes the protection afforded by folic acid by preventing its reduction to more active materials. Folinic acid, because it is already reduced, is unaffected by prior administration of

aminopterin and can substitute for the biologically active derivatives of folic acid. The measurement of liver citrovorum factor after the administration of folic acid provides an in vivo assay of the enzymes responsible for this conversion.

The citrovorum-factor content of the livers of (C57 × DBA)F₁ male mice was determined by incubation of acetone powders with ascorbate and histidine and subsequent microbiological assay with *Pediococcus cerevisiae* (ATCC No. 8081), as described elsewhere (2). The influence of amethopterin (0.05 mg/kg) on the liver citrovorum factor after administration of folic acid (25 mg/kg) on the days indicated is presented in Fig. 1. In the animals that received no amethopterin (day 0), liver citrovorum factor increased from 50 to 140 μ g/g in the first 3 hours after folic acid was given. On subsequent days, after administration of amethopterin, this response was abolished and had not been completely re-established by day 4, the last day of observation. Thus, in this experiment, the conversion of folic acid to citrovorum factor was inhibited completely by a very small dose of amethopterin.

The degree of inhibition of the conversion of folic acid can also be determined by observing the protective effect of previously administered folic acid on the toxicity of amethopterin. The data summarized in Table 1 show that administration of folic acid (25 mg/kg) 1 hour before administration of amethopterin increased the LD_{50} from 200 to 350 mg/kg. The administration of amethopterin (0.1 mg/kg) 24 hours before the LD_{50} injections abolished this protective effect.

Inhibition of the conversion of folic acid to liver citrovorum factor was produced by administration of 0.05 mg of amethopterin per kilogram of mouse, or 1 μ g for a 20-g mouse. If all of the drug were localized in the liver, the concentration would be 2 μ mole/g of liver. Since the amount of folic acid reductase in 1 g of mouse liver can bind 0.8 μ mole of amethopterin in vitro (3), these results suggest that at this low dose of amethopterin most of the drug was bound to this enzyme. The disappearance of the protective action of previously administered folic acid after such a small dose of amethopterin further demonstrates the effectiveness of amethopterin in inhibiting the action of this enzyme.

Table 1. Protective effect of previously administered folic acid on the toxicity of amethopterin.

Prior treatment	Time before amethopterin administration (hr)	Amethopterin LD_{50} (mg/kg)
None		200
Folic acid (25 mg/kg)	1	350
Amethopterin (0.1 mg/kg) and folic acid (25 mg/kg)	24	180
	1	

If doses of amethopterin several thousand times smaller than the LD_{50} completely inhibit the conversion of folic acid to citrovorum factor in the intact mouse, larger doses cannot increase the degree of inhibition and therefore must produce toxicity via some additional mechanism. It is not possible to account for all the effects of the folic acid antagonists solely on the basis of inhibition of this conversion process. Because all these effects can be reversed by administration of folinic acid, the additional sites of action may involve the further metabolism of tetrahydrofolic acid and its derivatives (4, 5).

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13 June 1961

An Overview of Sleep as an Experimental Variable (1940-1959)

Abstract. Less than one half of 1 percent of the psychological literature relates to sleep. Although there has been a relative decline in such research, the central nervous system and pathological aspects have recently received increased attention. The United States is producing less than 17 percent of the research on sleep.

In a recent review of the research literature on sleep, some statistics of interest regarding this research area were assembled. The review covered the primarily psychological research since 1941, since Kleitman's book, pub-

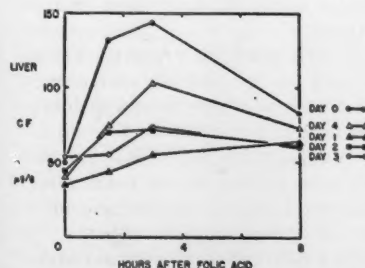


Fig. 1. The effect of amethopterin (0.05 mg/kg) on liver citrovorum factor derived from folic acid (25 mg/kg). Folic acid was given without amethopterin (day 0) and after amethopterin (days 1, 2, 3, and 4). Each point represents the mean for two mice. Amethopterin and folic acid were given subcutaneously.

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lished in 1939 (1), presents comprehensive coverage of the research to that date.

The most obvious fact to emerge was the relative neglect of this important behavioral variable. *Psychological Abstracts*, published by the American Psychological Association, covers the psychological literature published in the United States as well as that published in a number of foreign journals. The average percentage of the abstracts on the topic of sleep (exclusive of dreams) between 1940 and 1959 was 0.267, or slightly over 2½ articles per 1000. This percentage ranged from a high of 0.45 in 1945 to a low of 0.12 in 1954. In the last 10 years the relative amount of literature on sleep has been below this average, and such studies appear to be decreasing relative to other research.

The *Current List of Medical Literature* (now *Index Medicus*), published by the National Library of Medicine, has a broad coverage of journals in both a disciplinary and a geographic sense. In addition to articles from strictly medical journals, many psychological, physiological, biological, pharmacological, anatomical, and other related journal articles are listed by title from countries throughout the world. In a recent 2-year period (1958 and 1959), 221,256 titles were listed. Of these, 235 were concerned with sleep—or approximately 1 article per 1000.

An added confirmation of this neglect was found in ten of the most recently published introductory psychology texts. Of these texts, four contained no reference to sleep at all. In the remaining six, such references varied from 2 paragraphs in 443 pages to 14 paragraphs in 648 pages. In all, a total of about 7½ pages (approximately 0.1 percent) of these texts were devoted to describing one-third of man's activity.

In considering the kind of research, however limited in amount it may be, the research studies reported since 1940 in *Psychological Abstracts* were classified into those in which sleep was a dependent variable (studies of effects of experimental variables on sleep) and those in which it was an independent variable (studies of the effects of sleep on other experimental variables).

Figure 1 presents data on studies of sleep as a dependent variable. The category "environmental factors" included studies of the effects of submarines, day nurseries, air raids, night

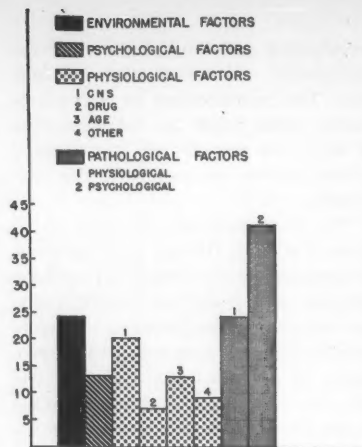


Fig. 1. Sleep as a dependent variable.

shifts, and light and sound. "Psychological factors" included studies of the effects of attitudes, activities prior to sleep, hypnosis, and similar conditions. Most of the "age" studies were observational studies of sleep cycles in children and in the aged. The "physiological" studies revealed an increasing interest in the role of the reticular formation and in central-nervous-system stimulation. Other physiological studies included studies of the effects of hypothalamic extracts, cerebrospinal-fluid conditions, and comparative studies of hibernation. Relations between sleep and a wide variety of pathological conditions received considerable attention: epilepsy, encephalitis, tumor, and others, among the physiologically centered conditions, and neuroticism, homosexuality, anxiety states, and others, among the psychological conditions. In only one category, the

effects of drugs, has there been a general increase in research in the last 10 years.

Figure 2 presents data on studies of sleep as an independent variable. By far the most widely studied central-nervous-system response variable is the electroencephalographic response. Such studies have shown a marked increase over the last 10 years. Blood pressure, basal metabolism, and the psychogalvanic skin response were the most widely studied of the autonomic responses. Nearly all of the observations on motor response were on general motility and eye movements. Threshold studies, primarily of auditory stimuli, were categorized under "sensory" processes. Studies of blood anoxia are the most common type under the "other" category. Most of the studies categorized under "psychological states" were concerned with the question of learning during sleep. Other studies included studies of the effects of such variables as "feeling rested" hypnagogic reverie, and near-waking states.

There has been an increasing amount of research on the influence of sleep on pathological states over the last 10 years, which undoubtedly stems from a general increase in interest in psychopathology among psychologists and is related to the significant increase in the use of sleep as a therapeutic by the Russians and the French. There has been a steady interest in sleep-loss studies—studies of the effects of sleep deprivation on various psychological and physiological variables—over the years.

As is shown in Figs. 1 and 2, in more than half the studies sleep was the independent variable, and more than half were physiologically oriented. In addition to the studies represented in Figs. 1 and 2, some 19 reviews of certain aspects of sleep have been abstracted.

Who is doing the research on sleep? Because of its extensive coverage of the literature in general and of foreign literature in particular, the *Current List of Medical Literature* was used as a source of information on this question. The percentages of articles, by country, for the years 1958–59 for the 235 articles related to sleep were as follows: United States, 17 percent; U.S.S.R., 20 percent; Germany, 18 percent; France, 13 percent; Great Britain, Canada, and Australia, 12 percent; Italy, 5 percent; Czechoslovakia, 4 percent; other countries, 9 percent. Since this source undoubtedly favors coverage of American

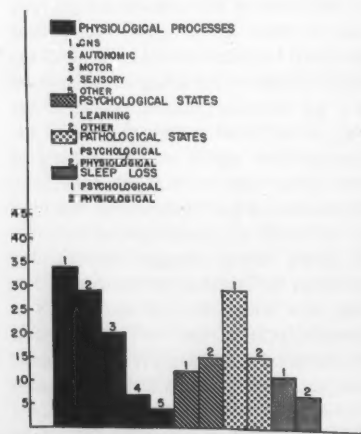


Fig. 2. Sleep as an independent variable.

articles, the 17 percent of current research attributed to the United States by this survey is undoubtedly spuriously high.

The Russian journals display a strong interest in the therapeutic aspects of sleep. Most of the German reports center on the effectiveness of various drugs in dealing with insomnia and more exaggerated sleep disturbances.

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13 January 1961

Miniature Subcutaneous Frequency-Modulated Transmitter for Brain Potentials

Abstract. A device for broadcasting electrical signals from the brain of an animal is described. It is small enough to be implanted under the animal's skin. That signals are broadcast without distortion is shown by the comparison of a broadcast recording of an electrocorticogram of a cat with a simultaneous recording made directly with wire leads.

In recent years physiologists have been concerned with the study of the relationship between the electrical activity of the brain of an animal and its behavior. It is common practice to implant electrodes subcortically and connect them with wire leads to a sensitive

recording apparatus. This technique has the disadvantage of artificially restraining the animal and impeding normal behavior. Radio telemetry can be used to eliminate the wires (1). A transmitter small enough to be implanted under the skin of the animal would be ideal.

Some requirements of a transmitter for this application follow:

1) The input impedance should be several times the source impedance in order to record essentially the open-circuit voltage. Measured source impedances were of the order of 15,000 ohms.

2) The frequency response should be nearly perfect in the range from 1 to 1000 cy/sec.

3) Transmitted signals with peak-to-peak magnitude as small as 50 μ v should be intelligible to a good antenna-receiver system located within 100 feet of the animal.

4) The circuit should contain the fewest possible number of components consistent with the foregoing requirements in order to lend itself to miniaturization and implantation.

The circuit diagram of a transmitter which meets these requirements is shown in Fig. 1. The second stage is an amplifier-modulator-oscillator, essentially as developed by Thomas and Klein but with fewer components and a different type of transistor (2).

Sufficient circuit amplification is provided in the second stage; however, the input impedance of the second stage is about 25,000 ohms, which is consider-

ably less than the required value. The first stage is needed to increase the input impedance. It is an emitter-follower which uses the direct-coupled input impedance of the second stage as its load (3).

A photograph of the transmitter and its battery is also shown in Fig. 1. Assembly was accomplished by mounting standard miniature components upon a substrate. Conventional soldering techniques were used. Before implantation, the transmitter was encapsulated in a polyethylene resin.

Measured characteristics of the transmitter are as follows: carrier frequency, 94 Mcy/sec; input impedance, 250,000 ohms; frequency response, 3 db down at 0.1 cy and 16 kcy/sec; deviation sensitivity, 8 mv (r.m.s.) for ± 100 kcy/sec; equivalent noise input, 5 μ v (r.m.s.) with 20,000-ohm source resistance and 16-kcy/sec bandwidth; weight with battery (encapsulated), 7.3 g; volume (encapsulated), 5 cm³; battery drain, 500 μ a. Battery life is approximately 48 hours when the smallest commercially available battery is used (two Mallory cells, type RM-312T2, in series).

Two electrocorticogram tracings taken from a single pair of electrodes implanted in the cortex of a cat are also shown in Fig. 1. The upper trace is the signal which was broadcast to an FM receiver before it was recorded. The lower trace was recorded simultaneously with wire leads from the same pair of electrodes. An electroencephalograph was used as the recorder in both cases.

Satisfactory recordings of other brain potentials have been made with all leads and the transmitter implanted subcutaneously.

With the advent of more efficient transistors of smaller size, a transmitter of about one-third the size of the one described here has been fabricated. A system whereby the battery may be recharged by induction while remaining in the animal is being investigated. Also under investigation are methods of providing for several channels of information (4).

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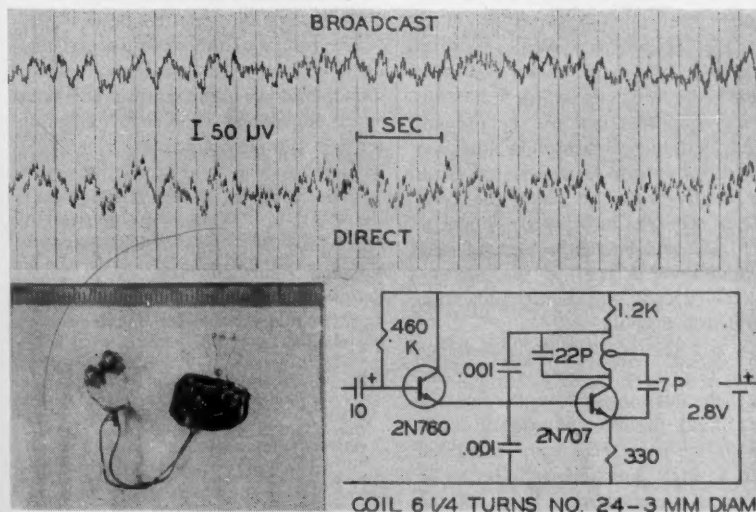


Fig. 1. (Top) Comparison of broadcast (upper trace) and direct-wire (lower trace) electrocorticogram of a cat. (Bottom, left) Photograph of the FM transmitter before encapsulation. (Bottom, right) Circuit diagram of the FM transmitter.

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10 July 1961

Passage of Saccharides from Cerebrospinal Fluid to Blood

Abstract. Saccharides with a molecular weight ranging from 182 to 50,000, which enter the cerebrospinal fluid at extremely slow rates when administered intravenously, all pass readily at similar rates from cerebrospinal fluid to blood after injection into a lateral cerebral ventricle. The mechanism of transfer appears to be a filtration of cerebrospinal fluid across a sieve-like boundary possibly located at the arachnoid villi.

There is considerable evidence that drugs and other foreign organic compounds diffuse from plasma into cerebrospinal fluid at rates dependent on their lipid solubility. For example, organic acids and bases in general enter cerebrospinal fluid mainly in their undissociated form at rates roughly parallel to the lipid-water partition coefficient of these drug forms. Moreover

lipid-insoluble organic ions such as quaternary ammonium compounds and sulfonic acids, as well as lipid-insoluble molecules such as sulfaguanidine and sucrose, penetrate into cerebrospinal fluid at very slow rates (1). In contrast, the transfer of drugs in the reverse direction—that is, from cerebrospinal fluid to plasma—does not appear to be highly dependent on lipid solubility. For example, Mayer *et al.* (2) have shown that, after intracisternal injection, compounds with low lipid solubilities leave the cerebrospinal fluid almost as rapidly as those with high lipid solubilities. Thus, drugs may pass from blood to cerebrospinal fluid by diffusion across a lipid-like boundary, but they appear to pass from cerebrospinal fluid to blood mainly in a different way.

The investigation reported here is an attempt to describe the nature of the boundary across which substances pass from the cerebrospinal fluid into the blood stream. Lipid-insoluble foreign substances were investigated, since they would be unable to leave the cerebrospinal fluid by way of the lipid-like barrier between it and blood.

Five microliters of a solution of inulin-carboxyl- C^{14} , sucrose- C^{14} , or mannitol-1,6- C^{14} was injected into a lateral cerebral ventricle of male albino rabbits (2.1 to 2.3 kg) anesthetized with ether. Injections were made with the aid of a stereotaxic instrument which held the injection needle firmly in place throughout the experimental period, thereby preventing leakage of cerebrospinal fluid through the puncture. After the injection, the compounds moved rapidly toward the subarachnoid space, appearing in the cisterna magna within 5 minutes. Direct evidence that the compounds readily left the cerebrospinal fluid was provided by their detection in urine. The relative rates at which the compounds appeared in urine are shown in Fig. 1; 52 percent of the injected dose of inulin, 38 percent of the sucrose, and 23 percent of the mannitol were excreted in 6 hours.

To ascertain whether the appearance of the substances in urine was a measure of the rates of exit from the cerebrospinal fluid, the rates of urinary excretion of the substances were compared after a single intravenous injection in groups of three animals. Most of the inulin (92 to 95 percent) was excreted in 6 hours; sucrose was excreted to the extent of 82 to 94 percent, and man-

nitrol, to the extent of only 76 to 82 percent. Little or no additional mannitol was recovered between the 6th and 7th hours after injection, suggesting that the compound may be metabolized or localized in the body. In any case, the incomplete recovery in urine of intravenously injected sucrose and mannitol suggests that these compounds had left the cerebrospinal fluid more rapidly than was apparent on the basis of their appearance in urine.

Evidence that sucrose, mannitol, and inulin leave the cerebrospinal fluid at similar rates was obtained on comparing the decline in concentration of the three saccharides in the fluid. The concentrations in cisternal cerebrospinal fluid 6 hours after intraventricular injection, expressed as a percentage of the dose in 1 ml of cerebrospinal fluid, were as follows: inulin, 10.1 (S.E., ± 0.6 in nine animals); sucrose, 10.2 (S.E., ± 1.0 in five animals); and mannitol, 8.1 (S.E., ± 0.4 in six animals). Preliminary experiments with dextran-carboxyl- C^{14} (molecular weight, 40,000 to 50,000) indicate that these large molecules pass from cerebrospinal fluid to blood at a rate almost the same as that of the other saccharides studied.

There is considerable evidence that cerebrospinal fluid flows from the cerebral ventricles toward the subarachnoid space and then filters across the arachnoid villi into the dural venous sinuses (3). This process of filtration or "bulk flow" into the blood stream would explain the essentially one-way transfer of lipid-insoluble molecules observed in the investigation reported here.

The results of this study suggest that drugs in general may pass from cerebrospinal fluid to plasma at similar rates by a nonspecific process of filtration across a porous boundary.

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3 July 1961

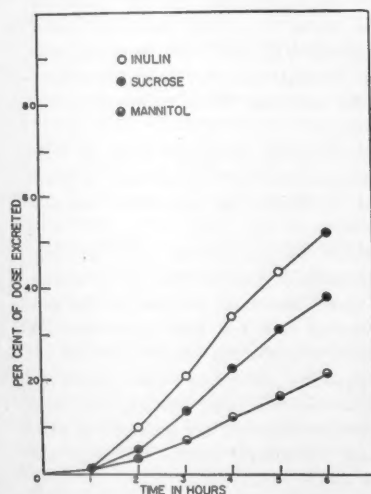


Fig. 1. Rates of appearance in urine of substances injected into a lateral cerebral ventricle of anesthetized rabbits. Each point represents the mean value for five animals. The standard errors for the points ranged from ± 1 to ± 3 . The doses of the C^{14} -labeled substances in (mg/kg) were as follows: inulin, 0.15; sucrose, 0.20; mannitol, 0.05. The total radioactivity administered was 1 to 2 μ c.

National Academy of Sciences

Abstracts of Papers Presented at the Autumn
Meeting, 29 October, La Jolla, California,
30 October–1 November 1961, Los Angeles

Study of Rapidly Running Transitions at High Pressures

Diamond anvils have been used in a "squeezer-type apparatus to follow high-pressure transitions with a recording x-ray diffractometer. The surface of the diamond presses against a lower Carbonyl anvil with the sample, in the form of a thin disk, held between the two surfaces. Clear x-ray patterns are obtained with pellets less than 3 mm in diameter, and they yield information on equilibrium pressure and on transformation rates.

LEASON H. ADAMS, BRIANT L. DAVIS
University of California, Los Angeles

Terrestrial Age of Iron Meteorites

We have been engaged in a program of determining the amounts of a large number of radioactive and stable nuclides produced by cosmic rays in iron and stone meteorites. The main purpose of this work has been the study of possible time variations in the cosmic ray intensity over long periods in the past. However, as an interesting by-product, these measurements also provide a method for measuring the time lapse since the fall of the meteorite.

It has usually been assumed that iron meteorites disappear by weathering in a relatively short period, at least in most climates. The meteorite Williamstown contains only about 25 percent of the amount of chlorine-36 (half-life, 3×10^6 years) found in recent falls which are similar in other respects. This indicates a terrestrial age of approximately 600,000 years. This meteorite was found in Kentucky. Recent data of Wanke and others indicates that terrestrial ages of this order of magnitude are not an unusual phenomenon.

The great resistance to corrosion shown by these meteorites is rather puzzling.

JAMES R. ARNOLD
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The Sun's Magnetic Cycle

Observations of the varying pattern of weak magnetic fields distributed over the surface of the sun have been under way with the solar magnetograph for 8 years. Two significant results are as follows: (i)

the sun has a poloidal field that reverses its polarity near the peak of the sunspot cycle; and (ii) local magnetic areas, responsible for sunspots and other forms of solar activity, disappear by expanding.

A new theory of the solar cycle based on these findings calls on the differential rotation to draw out the submerged lines of force of the poloidal field into an amplified, shallow, spirally wound sheath, which grows to a critical intensity, necessary for the emergence of unstable bipolar loops, first at moderate latitudes and then progressively closer to the equator, according to the derived formula $\sin \phi_c = 1.5/(n + 3)$. This represents Spörer's law of sunspot latitudes and the Maunder "butterfly diagram." The amplification factor is about 50, and the total length of magnetic "flux rope" formed is ample to account for the few thousand sunspot groups formed in each cycle. The process is repeated every 11 years, with alternating magnetic polarity.

Expanding loops of the field lines above surface bipolar magnetic regions, together with enlargement of these regions, accounts for neutralization and reversal of the initial poloidal field and for the continuing release of detached flux loops of low intensity in the solar corona. The eventual dissipation of the magnetic energy of the flux loops, through Joule heating, is estimated to provide some 10^{26} ergs in each sunspot cycle; this may be a significant energy source for the corona.

HORACE W. BABCOCK
Mount Wilson and Palomar Observatories

Photoproduction of Hydrogen Gas Coupled with Photosynthetic Phosphorylation

Cells containing the enzyme hydrogenase are known to produce hydrogen gas from organic substrates. We have recently shown that the photosynthetic sulfur bacterium *Chromatium* (known to contain hydrogenase) can produce hydrogen gas from a reduced sulfur compound (thiosulfate), but only under the influence of light. We have interpreted the photoproduction of hydrogen from thiosulfate by *Chromatium* as another line of evidence for the electron-flow theory of photosynthesis, which ascribes the same primary

photochemical act to plants and photosynthetic bacteria: the photoproduction of transferable electrons by illuminated chlorophyll molecules [*Nature* **190**, 601 (1961); **184**, 10 (1959)]. Photoproduction of hydrogen gas thus occurs when thiosulfate donates electrons to chlorophyll (via cytochromes) and hydrogenase catalyzes the combination of these electrons ("expelled" from the light-activated chlorophyll) with protons from the medium. We have now obtained a light-dependent production of hydrogen gas by spinach chloroplasts supplemented with a partly purified hydrogenase from *Chromatium* (free from bacteriochlorophyll) and with cysteine as the electron donor. The photoproduction of hydrogen gas by isolated chloroplasts was accompanied by the formation of adenosine triphosphate. These findings provide further support for the identity of the primary photochemical act in plant and bacterial photosynthesis.

DANIEL I. ARNON,
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University of California, Berkeley

Studies of Integrative Processes in Cerebral Systems Based on Mathematical Analysis of Electroencephalographic Records

The ubiquitous nature of rhythmic wave processes in cortical and subcortical structures in the normal waking brain has long been recognized. These processes have been shown to occur independently of actual neuronal firing in the majority of the neurons in the participating population, and the relationship of neuronal firing to a particular phase of the wave process has remained unclear. Many investigators have regarded the wave process as a "noise" in the cerebral system, not clearly related to information handling mechanisms.

However, a careful reappraisal of this problem in the electroencephalographic records during training and subsequently during performance of a learned task in animals has disclosed close correlations of phase patterns between different brain regions with the level of learning. In the fully trained animal, further close relationships in phase patterns have been discerned to the correctness or incorrectness of a discriminative motor performance. In these studies, we have used auto-correlation and cross-correlation techniques, and have initiated the use of cross-spectral analyses which permit assessment of phase patterns across a spectrum of frequencies.

In attempting to model a cerebral system, the results suggest the possibility that individual neurons may function as phase comparators for graded, analog wave processes sweeping across their surfaces in spatiotemporal patterns. Electronic wave processes apparently arise mainly in dendritic mechanisms and in presynaptic terminals. Since altered impedance loading offered by adjacent cellular elements on the dendritic electrotonic generator may account for altered frequency patterns, we have developed a new technique for direct impedance measurement, to attempt assess-

ment of relative significance of intraneuronal, intragial, and extracellular compartments in genesis and modification of wave processes. The proposed model of cerebral neuronal organization would thus be a nonlinear and probabilistic one.

W. R. ADEY

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The 5577-Angstrom Airglow

It was suggested 30 years ago by Chapman that the excitation source of the 5577-A atomic oxygen green line, which is the most intense of the night airglow emissions, lies in the recombination energy of the oxygen atoms that are present in the upper atmosphere as a result of daytime photodissociation. Recent laboratory experiments have shown, however, that the simple three-body atom recombination mechanism that was proposed is not an acceptable physical process to explain the observed upper-atmosphere emission. The following hypothesis of green line excitation is presented here. Two oxygen atoms recombine in a three-body collision to produce an oxygen molecule in an electrically excited state. This excited molecule will either radiate or undergo a deactivating collision with an oxygen atom. If the electronically excited molecule lies in certain vibrational levels, the electronic energy of the molecule may be transferred to the atom to produce an oxygen atom in a 1S state from which the 5577-A line is subsequently radiated. This hypothesis predicts that at high altitudes the intensity of the green line will be proportional to the square of the oxygen-atom density times the total-particle density, while at low altitudes it will depend on the cube of the atom density. Measurements of the 5577-A intensity variation with height that have been made in Naval Research Laboratory rocket experiments are interpreted to support this theory.

CHARLES A. BARTH

California Institute of Technology

Rhythmic Oscillations in the Potential of *Halicystis*

Increased potassium content of the sea water bathing impaled cells of *Halicystis ovalis* (especially in the range 0.12 to 0.18M KCl) produces rhythmic decreases in potential, with amplitude up to 80 mv and periods of 8 to 15 minutes. These oscillations often damp out after a few cycles, but occasionally as many as 20 oscillations have been observed. After return to sea water for several hours, the cells can again display the oscillations on exposure to increased concentrations of KCl.

The oscillations have a rapid falling phase, followed by slower recovery, sometimes with a "hump," a "shoulder," or both. The recovery phase often overshoots the original sea-water potential—for ex-

ample, rising to some 90 mv positive. Increasing the concentration of KCl (to 0.25, 0.3, and 0.4M) decreases the magnitude, but not the period, of the oscillations. Decreasing the temperature from 20° to 8° or 10°C increases the period to about 45 minutes.

When oscillations have ceased, illumination of the cell (200 ft-ca) often causes one or more new oscillations, sometimes of greater magnitude than those that occur in the dark. Two or three minutes of such illumination is sufficient to trigger the whole response, and properly phased light and dark periods can generate a long train of oscillations, which, however, eventually damp out, like those that occur in darkness or diffuse light.

The oscillations somewhat resemble those generated in the porous membrane system of Teorell, but the waves are not sinusoidal, no movement of water or change of hydrostatic pressure was observed in inserted capillaries, and electro-osmosis cannot be great in the high salt concentrations present (0.6M). A rhythmic loss and recovery of sensitivity to the potassium ion is postulated as the cause.

L. R. BLINKS, BARBARA M. POPE
Hopkins Marine Station

Problem of Information Transfer in the Brain

The interest of neurophysiologists has long been held by the question of how the brain receives information, both from its external and its internal environments. The era of belief in a ubiquitous all-or-none law for the activity of neurons early focused attention on the discharge of nerve cells, on the temporal and spatial patterns of their firing.

This model, essentially a deterministic one, has inevitably become more complex since microelectrodes have revealed that not all cells signal a given event in the same way; some may start to fire, others may cease their tonic firing, others may reveal some more subtle change. On which of these classes of "coding" is the brain to operate? What is the pattern of incoming message that results in the brain's taking action, for not all afferent impulses evoke an efferent discharge?

In recent years, and stemming largely from an interest in information theory, several workers have been exploring the possibility that a probabilistic model may prove to be a useful hypothesis from which to design experiments.

A probabilistic approach would postulate that information is conveyed by the selection of an item by virtue of its probability of occurrence when compared with a multitude of other possible items. It would be the dissimilar, the novel, the unexpected that would carry the message. Such a concept, then, would require study of average activity, for the brain would take action only when the average activity differed significantly from that to be expected by chance.

The deterministic model makes the assumption that the codes lie in the be-

havior of the single units and that some massive computational analysis of these individual reports is made by the brain.

The probabilistic model makes the assumption that it is the profile of activity in a population of neurons that is the determining factor.

An experimental exploration of the latter approach will be reported.

MARY A. B. BRAZIER
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Photoelectric Test of World Models

The most powerful test of world models is the relationship between the red shifts and the bolometric luminosities of galaxies belonging to clusters, but red shifts considerably beyond the usual spectrographic limit at $\Delta\lambda/\lambda \sim 0.2$ are needed to make this test decisive. The red shifts of three clusters of galaxies beyond $\Delta\lambda/\lambda \sim 0.2$, as well as those of five nearer clusters, have been observed by a completely photoelectric method undertaken in 1955. Galaxies are measured photoelectrically at six or eight wavelengths ranging from 3700 Å to 1 μ , and the observations are translated into spectral-energy distribution curves. These curves are displaced from one another both in wavelength and in luminosity. The wavelength displacement yields the red shift.

The largest red shift thus observed photoelectrically is $\Delta\lambda/\lambda = 0.44 \pm 0.03$ ($\Delta\lambda/\lambda =$ about 132,000 km/sec) for the faint cluster of galaxies found by Minkowski in the position of Cambridge Radio Source 3C295. This result is confirmed by Minkowski's spectrographic detection of an emission line, evidently O II 3727, at 5448 Å.

Pending further work, the results to date favor an exploding universe which will collapse again after a long time. Compatibility with the steady-state universe of Hoyle, Bondi, and Gold appears unlikely.

WILLIAM A. BAUM
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Evidence for a Category of Electroreceptors in the Lateral Line of Gymnotid Fishes

A glass capillary ultramicroelectrode was inserted into the exposed lateral line nerve of otherwise intact *Gymnotus* and *Hypopomus*. Spike activity of single fibers was recorded while the fish maintained the normal continuous discharge of the weak electric organs. The only activity in the fibers here reported is a short burst of spikes at 200 to 500 per second, following each discharge (3 to 30 per second) of the electric organ. The number of spikes in a burst changed systematically as conductive objects came near. A small conductive object right over the receptor decreased the number; when the object was just in front of or behind the receptor, it increased the number. Moderate water currents or stroking the skin with a soft brush caused

no spikes. It is concluded that these fibers serve as true electroreceptors.

An imposed pulse of current in the water produced a similar burst of spikes at the onset in one polarity, at the termination in the opposite polarity. The threshold was 5 to 30 mv/cm in the water near the surface of the fish. Sensitivity to changes in imposed current above threshold is high: an additional impulse in each burst is produced by an increase of 1 to 10 percent in pulse voltage. Increasing the duration of the imposed pulses from 1 to 4 msec caused an increase in the number of spikes, but a further increase from 4 to 100 or more msec added no more spikes to a burst of, for example, 20 msec duration. The voltage is coded in the burst, with the time constant shorter than an ordinary burst or a normal interval between the discharges of the electric organ.

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Experimental Evidence for a Basal Slip Mechanism in Quartz

Large plastic deformation of single crystals of quartz and well-bonded quartzite has been achieved for the first time in the "cubic" high-pressure device of Griggs, at temperatures from 300° to 1300°C and confining pressures from 14 to 40 kb. Single crystals of several orientations have suffered plastic deformation in compression. The deformation is not at all homogeneous, and specimens shortened by more than 1 percent are characterized by deformation bands, deformation lamellae, or continuous bending of the lattice (undulatory extinction). The structures were examined in thin sections with a polarizing microscope and universal stage. In crystals deformed with high shear stress on the basal plane, deformation bands almost parallel to the c-axis and lamellae almost parallel to the base are well-developed; lamellae parallel to the c-axis, associated with bands parallel to {0001}, are also present, but rare. Textural relationships of bands and lamellae suggest that the lamellae are very thin deformation bands. Lattice rotations within deformation bands parallel to the c-axis strongly suggest that the deformation mechanism is slip on $T = (0001)$. The near-basal bands and lamellae are interpreted as bands of secondary slip. There is evidence that the direction of slip (ℓ) varies with the conditions of deformation. Crystals deformed so that the shear stress on {0001} is low or zero do not contain structures with the above orientations but show bands and lamellae of other orientations. Since these cannot be produced by basal slip, other slip mechanisms must also operate. Evidence from deformed polycrystalline aggregates indicates that basal slip takes place at lower stresses than the other mechanism or mechanisms.

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Mutational Studies in *Serratia marino*rubra

Two marine bacteria which have been studied have exhibited singular genomic stability in respect to ultraviolet-induced mutations. Various investigators have proposed that divalent ions, specifically Ca^{++} and Mg^{++} , might bridge negatively charged sites and impart structural stability to the chromosome. Kirchner and Eisenstark [*Bacteriol. Proc. Soc. Am. Bacteriologists* 21 (1957)] observed that genetic exchange occurred with an increased frequency in chelated or divalent ion starved cells. These observations led to an investigation of the possible role of divalent ions in stabilizing the genome of *Serratia marino*rubra, a representative marine organism.

Ultraviolet irradiation experiments in which cultures grown in the presence and in the absence of magnesium (the sole divalent cation in our defined medium) were compared yielded approximately a tenfold increase in recovery of mutants from the Mg^{++} -deficient cultures. Survival after ultraviolet irradiation is not affected by deletion of Mg^{++} . These data are tentatively interpreted as supporting the theory of a structural role for Mg^{++} in native genetic material.

Recent observations by W. Hastings indicate that deletion of Mg^{++} also yields increased numbers of mutants in *Achromobacter fischeri*.

WILLIAM L. BELSER

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Radiation Damping of Spinning Particles

The disagreement in the literature on the basic classical equations of a spinning particle is summarized and the relations between the various theories are outlined. The theory of a charged particle with spin is developed for the case in which radiation damping is included and the particle may possess a moment of inertia about an axis orthogonal to the spin. It is found that the radiation damping terms may be formally eliminated from the equations of motion by redefining the momentum, mass and rate of change of spin. The redefined mass is no longer a constant of the motion and the supplementary condition, that the polar vector associated with the spin should vanish in the rest system, does not hold for the redefined spin.

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Bacteriophage MS2: Another RNA Phage

Bacteriophage MS2, isolated by John Clark as a phage which attacks an F^+ strain of *Escherichia coli* but not a corresponding F^- strain, appears to be an RNA-containing bacteriophage, similar to the f2 of T. Loeb and N. D. Zinder [*Proc. Natl. Acad. Sci.*

U.S. 47, 282 (1961)]. The phage is lysis-inhibited and provides a burst size of 10,000 to 20,000. It bands at a density of 1.46 in a CsCl gradient. It has an S_{20} of 81. Electron micrographs indicate a polyhedral structure of diameter about 24 μ m.

Nucleic acid, obtained from MS2 by phenol treatment, is infective to bacterial protoplasts [G. D. Guthrie and R. L. Sinsheimer, *J. Mol. Biol.* 2, 297 (1960)]. This infectivity is destroyed by ribonuclease but not by deoxyribonuclease (reciprocal controls were performed with the infective DNA of bacteriophage ϕX 174). The nucleic acid is infective to protoplasts of F^- strains as well as to protoplasts of F^+ strains.

JAMES E. DAVIS

JAMES H. STRAUSS, JR.

ROBERT L. SINSHEIMER

California Institute of Technology

Evaluation of Studies on Ultrastructure of Sieve Plates

The connecting strands of *Cucurbita* have a variable appearance under the electron microscope. Some views suggest intervacular connection between sieve elements through strands that appear to have an outer layer of cytoplasm and an inner core of vacuolar material; others show solid connecting strands. These variations may be traced, in part, to methods of preparing the material. The papers published thus far show solid connecting strands or strands resolvable into a system of fibrillar elements. Before the attempt is made to relate the ultrastructure of the sieve plate to the movement of solutes in the phloem, one needs to know which view illustrates most accurately the condition in the intact plant. The composition of the connecting strands in sieve plates cannot be fully determined until the relation between slime and cytoplasm in mature sieve elements is understood.

KATHERINE ESAU

VERNON I. CHEADLE

University of California, Davis

Isotopic Geochemistry of Volcanic Water and Steam

Isotopic, chemical, and field studies of waters and gases in geothermal areas have been made with the objective of determining the proportions of "juvenile" components from magmatic sources, and of "recycled" components, derived from material previously at the surface of the earth. Deuterium and oxygen-18 concentrations in surface meteoric waters of the earth vary by about 43 and 5.6 percent respectively, and are linearly related. These variations furnish natural isotopic tracers for the study of geothermal water and steam from areas with surface waters of quite different isotopic composition.

The deep circulating, nearly neutral pH, thermal springs, and volcanic steam of high pressure and temperature, show a characteristic "oxygen isotope shift," such

that the oxygen-18 concentration is increased, but the deuterium concentration is the same, relative to the isotopic composition of the local meteoric waters. This effect appears to reflect exchange of oxygen with rocks, and possible loss of vapor at temperatures of about 200°C at which there may be oxygen isotope, but no hydrogen isotope, fractionation. From these data it is possible to place limits on proportions of juvenile water in the areas studied.

Superficial acidic springs are characterized by quite different relations, reflecting a kinetic isotope effect in the evaporation of local surface waters. Such an effect also characterizes the evaporation of natural waters at ordinary temperatures. Low *P* and *T* steam fumaroles contain steam boiling off the water table in isotopic equilibrium.

HARMON CRAIG

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Evaluation of Studies on Ultrastructure of Tonoplast in Sieve Elements

The tonoplast has received relatively little attention in studies on the ultrastructure of plant cells. Published reports and our studies indicate that preservation of the tonoplast must be carefully investigated, especially in sieve elements because their mature protoplasts are so easily injured. Our comparison of young and old sieve elements of *Cucurbita* supports the concept that during nuclear disintegration the organelles, the cytoplasmic membrane systems, and the tonoplast break down. The ectoplast and the remnants of the other cytoplasmic structures appear to constitute the characteristically thin parietal cytoplasmic layer in mature sieve elements. This study stresses the importance of the ontogenetic approach in the study of the tonoplast, particularly in such a highly specialized cell as the sieve element.

KATHERINE ESAU, VERNON I. CHEADLE
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Transfer of Transplantation Immunity by Sensitized Lymphoid Cells

Mouse lymphoid cells were sensitized to skin homografts and were labeled with tritiated thymidine. When transferred to isologous hosts, the sensitized cells rejected the homologous skin grafts in an accelerated fashion, and few or no labeled lymphocytes were present in the rejection site. Mouse lymphoid cells were sensitized to skin homografts and within Millipore chambers were transferred to isologous hosts. The homologous skin grafts were rejected in an accelerated fashion when the chambers were placed subcutaneously at the periphery of the graft or intraperitoneally. There was no evidence of sensitized cells escaping from the chambers.

JOSEPH D. FELDMAN

JOHN S. NAJARIAN

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Quality of Piano Tones

Usually a pure tone is described by two parameters—namely, the frequency, in cycles per second, and the intensity level, in decibels at the ear of the listener. Similarly, a piano tone is thought of as a summation of pure tones which differ in intensity level and have frequencies which are integer multiples of the lowest frequency, called the fundamental.

This picture is far from adequate to describe the quality of piano tones produced by musicians. One must also describe the starting and stopping characteristics of the tone, called the attack and decay. Physicists have usually assumed that the decay of the component tones is logarithmic—that is, that the intensity level, in decibels, decreases uniformly with time. This is far from the truth, as will be shown by a careful analysis of such tones. For some of the components, the decay looks more like sinusoidal time variations than like logarithmic ones. In this paper typical curves showing such variations are given for as many as 30 overtones of a piano tone.

Also, it has been found that the frequencies of the component tones are not multiples of the fundamental—that is, they are not harmonic tones. For example, the measurements showed that for the note G⁴, the 33rd overtone was sharp from a harmonic series by as much as four semitones, the fundamental being 27.5 cy/sec and the 33rd overtone being 1144. It is this lack of harmonicity that gives the piano its characteristic quality, especially for the low-pitched tones below middle C.

A synthesizer was built which could produce 100 components having any frequency and intensity level. By means of dials and electronic controls, the attack and decay times could be set at any values between 0.001 second and 10 seconds. This machine was used to imitate actual piano tones and particularly to produce tones which were thought to be preferable from a musician's viewpoint.

A jury of musicians and also a jury of nonmusicians made judgment tests of these tones. In some cases the synthetic tones were preferred to the real piano tones, but in most cases it was difficult to improve upon the real piano tones, at least as judged by the musicians. A tone was tried which had components that were exact harmonics and intensity levels that were the same as those of the real piano tone. The tone with the inharmonic frequencies was definitely preferred by the musicians. They said that the tone with harmonic components sounded like an organ that had attack and decay characteristics like a piano. Some of the musicians expressed a desire to have available many of the synthetic tones but said these could not be called piano tones.

Piano-like tones resulted from the synthesizer when the attack times (the time required to reach 0.9 of the tone's maximum intensity) ranged from 0 to 0.01 second for notes below G and from 1 to 4 seconds for notes above G.

The overtone structure could vary over wide ranges and still the tone would be piano-like. For example, here are the lim-

its on overtone structure for a synthetic tone to be piano-like.

1) The intensity level of each overtone above the 5th should be between 1.5 and 2.5 decibels lower than that of the preceding one.

2) When the intensity level per overtone is higher than 2.5 decibels per overtone, the tone sounds more like a kettledrum.

3) When the intensity level is less than 1 decibel per overtone, the tone is too edgy and approaches the sound of a harpsichord. When very small, the tone becomes like the noise made by hitting a metal plate.

4) The relative intensity levels of the first five or six overtones can be changed in almost any manner and the tone, although its quality is changed, will remain piano-like.

5) The overtones must be inharmonic or the piano-like quality, particularly the liveness, is lost.

HARVEY FLETCHER, DONNELL BLACKHAM,
RICHARD STRATTON

Brigham Young University

Modulated Beam Experiments on Gas-Surface Interactions

The application of modulated atomic beam techniques to the study of the physical and chemical reactions between gases and solid surfaces has permitted the measurement of a number of parameters of these reactions and also has displayed a number of unexpected phenomena. The experiments have been of two types. In the first, a beam of atoms or molecules impinges against a solid surface, and particles leaving the surface are detected by a mass spectrometric neutral beam detector. Rotation of the detector permits measurement of angular distributions of the emitted particles, and signal strengths are used to deduce chemical and physical reaction probabilities and coefficients. The second type of experiment observes, through mass spectrometric detection, those particles emitted normal to a surface when particles from a hemispherical gas source impinge against it. In both cases, modulated techniques are employed to achieve clear distinction between the desired effects of the beams and effects arising from the residual gas in the vacuum of the atomic beam apparatus, and to determine reaction times in certain processes.

Among the processes for which quantitative information will be presented are condensation of gas molecules at surfaces, dissociation of hydrogen at hot tungsten, and thermal accommodation. Among the unexpected, and as yet inadequately explained, observations to be discussed are anomalous angular distribution of reflected particles and apparent time delays in certain chemical reactions.

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Displacement of the San Andreas Fault in Southern California

Three segments of a former east-west trending belt of terrane in southern California are interpreted as displaced horizontally about 130 miles on the vertical San Andreas fault and 30 on its branch, the San Gabriel fault, since the earliest Miocene. The terranes displaced by the San Andreas fault are characterized by distinctive rocks which range in age from Precambrian (?) to Lower Miocene. Basement types include augen gneiss and blue-quartz gneiss of the amphibolite facies which have been intruded by a complex of gabbro, diorite, anorthosite, and syenite, and all intruded again by granitic rocks. Associated distinctive rocks on both sides of the fault include basic dikes and mafic bodies rich in ilmenite and apatite, blue-quartz granite, quartz-bearing syenite, granophyre, and pegmatite. Greenschist, marine Eocene strata, and Oligocene non-marine beds and volcanics are also displaced. The San Gabriel fault separates similar rocks except for the anorthosite-syenite complex.

This combined displacement of 160 miles appears to be compatible with other studies along the San Andreas system. Younger and smaller displacements seem geometrically sound, but greater displacements of older features rest on arguments of a different order of acceptability. Additional study of the geology along faults for many miles is needed with emphasis on geometric analysis of gross elements and on a search for linear features, such as basin-margin lines and facies-change lines, to establish slip. Separations of low dipping units require study, and the possibility that such units have been displaced by trace slip needs more widespread recognition.

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University of California, Los Angeles

Radiocarbon from Nuclear Tests and Atmospheric Circulation

The recent increase of the C^{14} level in the atmosphere caused by the testing of thermonuclear weapons has been well established by many laboratories, and the measurements of this increase have been of assistance in studies of global atmospheric circulation. Over the period 1955-59 the C^{14} level in the Northern Hemisphere troposphere rose to 30 percent above normal, while during 1960 a decline was observed, showing that the transfer of C^{14} out of the troposphere into the ocean was greater than the transfer of C^{14} from the stratosphere. The C^{14} level in the Southern Hemisphere troposphere lagged behind that in the Northern Hemisphere over the period 1955-59, but equilibrium was reached in 1960, showing that the mixing rate between the two tropospheres is relatively rapid, about 1 or 2 years.

The sampling methods that have been used for all these measurements require a minimum of 3 days' continuous collection to obtain enough sample for C^{14} analysis. As use could be made of such C^{14} analyses

for many local atmospheric circulation problems if the sample could be collected more quickly, alternative sampling methods have been considered. A new method of sampling with molecular sieves, which can collect 10 liters of atmospheric carbon dioxide per hour, is now in routine use. Since the molecular sieves collect water as well as carbon dioxide, they operate most efficiently when the water content of the air is low. Some preliminary results that have been obtained with this sampler at sea level and in commercial jet aircraft flying at 30,000 feet will be presented.

G. J. FERGUSSON
University of California, Los Angeles

Patterned Responses in Second-Order Neurons of the Olfactory Bulb

The responses of the second-order neurons which receive impulses from the olfactory receptors are quite complex, since they show various patterns of inhibition and excitation to odoriferous stimuli. This patterning may be explained (i) on the basis of a mechanical factor, perhaps a boundary-layer phenomenon due to local air turbulences in the nasal passages; (ii) by the complexity of the synapse at the glomerulus; (iii) by local feedback paths of an inhibitory (negative) character which we can demonstrate in the bulb by antidromic stimulation of mitral axons; (iv) by a similar feedback path between the two bulbs through the anterior commissure antidromic stimulation of tufted cell axons; or (v) by feedback paths from other structures in the brain, notably the midbrain tegmentum.

In recent and so far unpublished work with Mancia and von Baumgarten, evidence for each of these effects has been obtained. From a physiological standpoint it is interesting to note that one implication of our results is transmission of information in the brain by the inhibition of spontaneously active neurons as well as by excitation. The observation has been made that an odor to the ipsilateral nostril may have a completely different effect from the same odor to the contralateral nostril in rabbits, despite the subjective impression of similarity of odor from either nostril in man. A second curious observation is that stimulation of brainstem structures may reverse the effect of an odor on the firing pattern of the cell, converting excitation to inhibition or vice versa.

JOHN D. GREEN
*School of Medicine,
University of California, Los Angeles*

Differentiation of Divergent-Production (Creative) Abilities in Young Adolescents

Earlier research on abilities believed to be important in creative thinking led to the differentiation by factor analyses of different skills, most of which have been classified under the headings of fluency of thinking, flexibility of thinking, and elaboration. All of these kinds of ability belong

in a larger category called "divergent production," for, in tests of such abilities, the examinee is given certain information from which he is to generate a variety of other items of information; there is no one right answer, but there is a potentially large number of acceptable answers.

Previously, the demonstration of different divergent-production abilities had arisen from the testing of groups of adult, young males, with I.Q. ranges above 100. The study reported was designed to see whether the same differentiations could be demonstrated in younger subjects, of both sexes, and at moderate I.Q. levels.

Four new factor analyses were performed on test scores obtained from several hundred 9th-grade students—one for boys and one for girls of moderate I.Q. levels, one for both boys and girls with I.Q.'s of 120 and above, and one for the whole range of 9th-grade students at one school.

Essentially the same factor structure was found in all the 9th-grade groups as in the adult groups. From a limited battery of tests given to 6th-grade students, much the same differentiations in kinds of ability were also found. In all groups, tests of divergent-production abilities proved to be relatively independent of tests used to measure the I.Q.

J. P. GUILFORD
PHILIP R. MERRIFIELD
ANNA COX

University of Southern California

Environmental Carbon Dioxide Concentration and Carbohydrate Metabolism in Liver

In the course of exploring, in vitro, environmental factors, such as pH, that quantitatively alter the pathways of carbohydrate metabolism in liver, it was observed that buffers other than bicarbonate-carbonic acid interfered with the conversion of glucose to glycogen. This led to the further observation that increasing the bicarbonate concentration in the incubation medium between 5 and 40 mM materially increased the amount of glycogen synthesized from glucose. This has also been found to be true with fructose, but not with pyruvate as substrate. In these experiments, the pH of the medium was held constant by appropriately varying the CO_2 tension.

When $HC^{14}O_2$ was used with unlabeled substrates, it was found that the percentage of $C^{14}O_2$ incorporation into liver glycogen is not influenced by the concentration of HCO_3^- in the medium. This result, coupled with the lack of effect of HCO_3^- concentration on conversion of pyruvate to glycogen, makes it seem unlikely that the primary effect of HCO_3^- concentration resides in carboxylation reactions.

On the other hand, paired experiments with C^{14} -labeled glucose plus unlabeled fructose and with C^{14} -labeled fructose and unlabeled glucose indicate that an increase in HCO_3^- concentration increases the degree of substrate phosphorylation.

The effect of varying pH, both by varying CO_2 tension with constant HCO_3^- con-

centration and by varying HCO_3^- concentration with constant CO_2 tension, has also been studied in relation to glycogen synthesis from different substrates.

The implications of these observations for the relation between carbohydrate metabolism and pathological variations in acid-base balance will be discussed.

A. B. HASTINGS, T. A. MAHOWALD,
DARRELL D. FANESTIL

*Scripps Clinic and Research
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Ion-Exchange Chromatography in Study of Complex Systems of Coordination Complexes

The power of ion-exchange chromatography in the investigation of the kinetics and stereochemical results of substitution reactions of coordination compounds will be illustrated by examples chosen mainly from the recent work of the author and his associates on reactions of chromium(III) complexes, with emphasis on the combining of ion-exchange chromatography with chloride-ion titrimetry and absorption spectrophotometry to resolve the products and follow the kinetics in the complex system formed when dichlorobis(ethylenediamine)-chromium(III) cations undergo aquation and isomerization reactions with ultimate formation of hexaquo chromium(III) cation. In the latter system there appear to be 11 interconverting chromium(III) species, for which 22 rate parameters have been evaluated.

CLIFFORD S. GARNER
University of California, Los Angeles

Effects of Steroid Antifertility Agents on Brain Function in Rabbit

The steroid sex hormones (estrogens, progestogens, and androgens) influence reproductive behavior and the release of gonadotropic hormones from the anterior pituitary gland. Differential blockade of the latter phenomenon, leading to temporary sterility, characterizes the action of new progestational antifertility agents which have already proved effective in women. In studies on nervous control of release of pituitary gonadotropin and ovulation in the rabbit, the effects of sex steroids on brain function have been investigated. Permanent electrodes have been implanted into the cerebral cortex and deep regions of the brain, and stimulation and electrical (EEG) recording studies have been conducted in the conscious, freely moving animal. The effects of treatment with steroids on two thresholds have been assessed: (i) an EEG-arousal threshold involving high frequency direct electrical stimulation of the midbrain reticular formation and (ii) an EEG-afterreaction threshold involving low frequency stimulation of the hypothalamus or rhinencephalon. The EEG-arousal threshold has been related to estrous behavior, whereas the afterreaction threshold is closely associated with the facility with which pituitary gonadotropin is released. High dosages of

estrogen or androgen maintain a low arousal threshold and an estrous condition, together with an elevated afterreaction threshold and blocked ovulation. However, undesirable side effects limit the usefulness of estrogen and androgen as antifertility agents. The newer progestational antifertility agents, including norethynodrel and norethisterone, differentially elevate the EEG-afterreaction threshold and appear to exert their critical blocking action on release of pituitary gonadotropin by this effect on the brain. In confirmation, the implantation of crystalline sex steroids directly into the hypothalamus inhibits the release of pituitary gonadotropin, whereas steroid implantation into the pituitary gland does not.

M. KAWAKAMI, CHARLES H. SAWYER
*School of Medicine,
University of California, Los Angeles*

Occurrence of Cellular Inducer of Galactose Metabolism in Mutants Defective in Galactokinase

The regulation (induction or repression) of the biosynthesis of the three *Escherichia coli* K-12 enzymes of galactose metabolism (K, T, and E) is of the coordinate type (M. B. Yarmolinsky, H. Wiesmeyer, E. Jordan, 26th Cold Spring Harbor Symposium, 1961; G. Buttin, *ibid.*). A number of mutants defective in galactokinase (K) have been shown to synthesize the next two members of the galactose sequence (transferase T_1 and epimerase E_1) without the usual repression (H. M. Kalckar and T. A. Sundararajan, *ibid.*). This break in the repression (seen in wild type K-12 *Salmonella* as well as in mutants defective in T and E) is probably not due to lack of repressor. Transduction of a K⁻ genotype (phenotypically derepressed with respect to the galactose sequence) by a λ gal stemming from a repressor minus strain (G. Buttin, *ibid.*) nevertheless provides a repressed heterogenote (M. B. Yarmolinsky, H. Wiesmeyer, E. Jordan, *ibid.*). The most plausible explanation for this complementation would be that galactokinase plays a role in the removal of a cellular inducer (H. M. Kalckar and T. A. Sundararajan, *ibid.*). Accumulation of sugar components characteristic for the K⁻ strains can actually be demonstrated. Their possible relation to or identity with occurrence of an endogenous inducer is now under study.

H. M. KALCKAR, T. A. SUNDARARAJAN
Johns Hopkins University

Some Highlights from the Natural Radiocarbon Datings of La Jolla Laboratory

The La Jolla radiocarbon laboratory, established and supervised by Hans E. Suess, has made noteworthy contributions to a wide range of natural sciences.

Many tests bear on geologic events, particularly changes in sea level. For local areas, datings indicate that the sharp rise between 10,000 and 7000 years ago was

then slackened but continued almost or quite to the present. Two tests indicate unexpectedly rapid aggradation of the Los Angeles Plain.

Coupled with faunal evidence and $\text{O}^{18}/\text{O}^{16}$ measurements, datings indicate a warmer-than-present ocean surface (and, by correlation, warm air temperatures) along the California coasts from 7500 to 1600 years ago, with a cold period from 1600 to 600 years before the present (B.P.), followed by return to warmer temperatures. Geomorphic and ecologic data, and habitational evidence in now parched areas, indicate greater-than-present rainfall during several millennia preceding the extreme drought of the past few centuries along these coasts and the adjacent deserts.

The last main stage of Lake LeConte is dated from 1580 B.P. until just before the exploration of the basin. Final recession of Lake Mohave is dated at 9640 B.P.; Lake Manix is dated at 19,500 years.

Pleistocene mammals of the La Brea tar pits are dated at 14,400 B.P.; the extinction of giant marsupials in Australia, at 26,300 B.P.

These and many other dates bear on the antiquity of man. Other dates bear on human prehistory, with particular reference to the paleoecology of man. Three dates bear on Mayan chronology, including one of the oldest known (2200 B.P.)

CARL L. HUBBS
University of California, San Diego

Tidal Winds and Pressure Changes in the Mesosphere

Determinations of air motions in the layers between 80 and 100 km by means of radio meteor observations have shown that the winds in this region undergo large tidal variations, with periods of 12 and 24 hours and with amplitudes of the same magnitude as the mean winds. From these wind oscillations the corresponding pressure oscillations can be computed under plausible assumptions. These computations show that the pressure amplitude is about 5 percent or more of the mean pressure (corresponding to a vertical displacement of the isobaric surfaces through 600 m or more during a period), while at the earth's surface the amplitudes are only about 0.1 percent of the mean pressure. This increase of the amplitudes is expected from the theory of atmospheric tides. At the earth's surface the diurnal oscillation is much less well developed and much more irregularly distributed than the semidiurnal oscillation, but in the high-atmosphere both oscillations appear to be of equal importance and of equally regular distribution over the globe.

Both oscillations show pronounced seasonal variations in the high atmosphere, much larger than at the earth's surface. For the semidiurnal oscillation these seasonal changes are in the same sense as those at the ground. In the case of the diurnal oscillation the seasonal variation is such as would be expected if the oscillation were produced by a thermal cause.

B. HAURWITZ
University of Colorado

Evidence Concerning Liquid Structure

In dealing with the theory of the liquid state, some authors have applied quasi-crystalline models, using terms such as *lattices, cells, holes, vacancies, and dislocations*. Eyring considers a liquid to be a mixture of "solid-like" and "gas-like" molecules.

I and others have adduced a variety of experimental facts indicating that the molecules of nonpolar liquids are in a state of maximum disorder. I here present one more piece of evidence.

Meta- and para-xylenes boil within 0.8° of each other, and their molal volumes between 100° and 15° parallel one another within 0.4 percent. Para-xylene freezes at 13.2° , meta-xylene at -47.9° , but the molal volume of para-xylene down to 15° gives no premonition of its freezing at 13.2° .

J. H. HILDEBRAND
GRAHAM ARCHER

University of California, Berkeley

Genetic Studies of Double Mutants at the *td* Locus of *Neurospora crassa*

Previous investigations dealing with primary CRM negative tryptophan synthetase mutants suggest that multisite lesions might be required for the formation of mutants of this type.

In the present investigation several CRM negative double mutants were obtained from a CRM⁺ mutant by appropriate selection techniques, and three of these have been studied in detail. Evidence obtained from crosses involving these strains and from reversion studies suggest that CRM negative double mutants differ markedly from primary CRM⁺ mutants, and suggest that these latter mutants are not multisite. The significance of these mutants for investigations dealing with the general problems of genic control of enzyme structure and interference phenomena observed in the mapping of closely linked alleles will be discussed.

SAM KAPLAN

University of California, San Diego

Occurrence of Gas Hydrates in the Solar System

The gas hydrates are clathrate compounds of gases in a distorted ice matrix. The dissociation pressures of methane, ethane, ethylene, acetylene, and carbon dioxide hydrates in equilibrium with ice and gas were measured at low temperatures. The dissociation pressures of a mixed hydrate—for example, a mixed hydrate of methane and ethane—can be estimated from the dissociation pressures of the pure hydrates. From these data it appears likely that methane hydrate or a mixed hydrate of methane, ethane, ethylene, and hydrogen is present on Uranus, Neptune, and the satellites and rings of Saturn. This hydrate is possibly present on Saturn, Jupiter, and the satellites of Jupiter. A carbon dioxide hydrate, or a mixed

hydrate of carbon dioxide and sulfur dioxide, is possible on Venus, but metastable ice would have to be present in the clouds. A mixed hydrate of nitrogen, carbon dioxide, and argon may exist at the polar caps and in the atmosphere of Mars, but this possibility also depends on the presence of metastable ice. Hydrates of air may be formed in the high clouds of the earth from either metastable ice or supercooled water. A mixed hydrate of methane, carbon dioxide, ethane, and so forth is likely to be present in comets. It is possible that hydrates are present in particles of interstellar dust.

STANLEY L. MILLER

University of California, San Diego

Progress in the Theory of Alpha Decay

Attempts have been made, mainly by H. J. Mang at the Theoretical Physics Institute of the University of Heidelberg, Germany, to understand how the α -particle is generated at the nuclear "surface" and is injected into the Condon-Gamow potential barrier surrounding the nucleus. Many experimental features can thus be accounted for in detail on the basis of the nuclear shell model in the region of the doubly closed shell nucleus Po^{211} . For example, the sudden increase of the transition probability above the neutron number 126 is traced back to the difference in angular momentum of the individual nucleon orbits before and after shell closure, and not to an assumed increase of the nuclear radius, as previously suggested by several authors. The theory explains quantitatively the fine structure of α -decay, exhibited in the branching ratios of transitions to different states of the daughter nucleus, as well as the angular correlations between α -rays and subsequently emitted γ -rays.

By this theoretical development α -decay studies can now be used as a source of information about the properties of nuclear states, especially spin assignments, with the same reliability as β - and γ -radiation studies have been used hitherto. The spin of the metastable state of Po^{211} has thus been uniquely determined to be as large as $25/2$ units of Planck's quantum.

On the same theoretical basis Mang and Rasmussen (Radiation Laboratory, Berkeley) have jointly begun to study the α -decay of highly deformed nuclei; they have obtained very promising preliminary results.

J. H. D. JENSEN

University of Heidelberg

COSPAR International Reference Atmosphere 1961

The results of an international study group, sponsored by the Committee on Space Research, are presented. The purpose of the group was to study upper-atmosphere properties by rocket and satellite observations. Upper-air densities have been obtained for the region from 200 to 800 km. The observed day and night variation of densities has led to a set of three nu-

merical tables, called "average values," "average minimum values," and "average maximum values." Related properties such as pressure, scale height, and temperature have been derived from the densities. It is shown that at an altitude of about 800 km, the temperature between daytime maximum (14 hr local time), and nighttime minimum (5 hr local time) might vary by as much as 600 degrees. These findings are based primarily on observations made during the years 1958–59 and on some observations made during 1960; that is, they apply to years of relatively high solar activity. Because of the "solar activity effect," the numerical values may vary during an 11- or 10-year solar cycle.

The accepted CIRA 1961 (COSPAR International Reference Atmosphere) tables have been compiled by R. L. F. Boyd, University College, London; H. LaGow, National Aeronautics and Space Administration, Washington; S. M. Polovskov, Academy of Sciences, Moscow; W. Priester, Sternwarte der Universität, Bonn; and this writer as the chairman of the group.

The work has been carried out with the additional support of the National Academy of Sciences and the University of California, Los Angeles.

HILDE KALLMANN-BIJL

Rand Corporation

Dispersion of Earthquake Surface Waves by a Shoaling Crustal Structure

It has been suggested that the dispersion of earthquake surface waves be used as a diagnostic tool in the determination of crustal and near-mantle structure. The problem is relatively simple to define and solve when the structures may be considered as "flat" or one-dimensional. A point of major departure from this type of structure occurs in the transition of the relatively thin oceanic crust to the thicker continental crust at the continental margins. The problem also arises in considering the structure of mountain ranges and the nature of edge waves in the ocean over a flaring continental shelf.

The problem is solved for the case of Love waves by a direct application of the method of images, developed originally by Sezawa, to the problem of wave propagation in a wedge-shaped crust underlain by a homogeneous mantle. The solution is expressed as a series. It is necessary to sum the series in order to find the singular points. This is done by a perturbation method for small values of the wedge angle. The solution is not restricted to the lowest orders however.

In the first order, the solution is that of a "flat" structure of crustal thickness equal to that below the point of observation. The higher-order corrections correspond to the influence of the inclined bottom of the crust. An interesting feature is that the perturbation may be expanded in a power series in the square root of the wedge angle. Numerical examples are provided.

L. KNOPOFF

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Endogenous Cofactors in Bacterial Photophosphorylation

This work was performed while we were in residence at Brandeis University and was supported by grants in aid from the National Institutes of Health (C-3649) and the National Science Foundation (G-6441).

Cell suspensions of *Rhodospirillum rubrum* yield, on sonification, chromatophores which can be depleted by washing with Tris buffer (pH 8) to give minimal photophosphorylation and dark phosphorylation rates. Restoration to a maximal rate can be achieved by adding exogenous agents, such as ascorbate or phenazine methosulfate, or endogenous cofactors, either combined as a "supernatant fraction" or as single purified components (flavins, heme proteins). The amounts of "supernatant factor" which produce the maximal photophosphorylation rate are equivalent to ascorbate at $2.2 \times 10^{-3} M$. This "ascorbate-equivalent" concentration for supernatant factor can be shifted to lower values when ascorbate is added together with flavins or the endogenous heme proteins (RHP or cytochrome c_b). Riboflavin and cytochrome c_b evoke special responses which indicate that the cytochrome is the natural terminal electron acceptor in the oxidation system which supports photophosphorylation, while the flavin is active at the phosphorylation site as a cofactor for the endogenous pyridine nucleotide-linked flavoenzyme heme protein reductase. Further, it appears that a circular chain of respiratory catalysts located in the chromatophores couples photoactivated electron-transport to phosphorylation optimally at an effective intrachromatophore mid-point potential of 0.0 ± 0.01 volt.

MARTIN D. KAMEN

University of California, San Diego

TAKEKAZU HORIO

Osaka University

Spectroscopic Investigation of Radiation from High Temperature Helium Plasmas at Pressures between 20 and 155 Atmospheres

The absolute radiative intensity distributions obtained from multipole electrical discharges in helium at pressures from 30 to 155 atm have been measured as a function of time and wavelength in the range from 3000 to 6000 Å. The light pulses which exhibited a $1/e$ width of 2.7 μsec were produced by simultaneously discharging ten 0.1 μF capacitors charged up to breakdown voltage. Each capacitor was built into an individual discharge circuit of 1.34-Mcy/sec ringing frequency and approximately 0.1-ohm dissipative resistance. From the intensity measurements peak discharge temperatures were deduced. It was found that over the investigated pressure range, peak temperature and the square of the breakdown voltage—that is, the discharge energy—can be represented by a linear relationship at fixed electrode configuration. Peak temperatures were determined to vary, depending on pressure,

between 42,000° and 63,000°K. Intensity distributions were observed to move towards limiting black-body intensities very rapidly with increasing pressures. At 155 atm, the highest pressure applied, intensities at no investigated wavelength were less than 0.45 black-body intensity. Because of electron densities of up to 9×10^{18} electrons/cm³, considerable influences on the spectral energy distribution were observed. Electron densities were estimated from the measured broadening of the HeI line $2p^2P^{\circ}-3d^2D$ at $\lambda_0 = 5876$ Å, and compared to those expected from the temperature measurements on the assumption of thermodynamic equilibrium. Agreement was found within the accuracy of the method. Measurements on the linear Stark-effect broadening of HeII, $n = 3 \leftrightarrow n = 4$, $\lambda_0 = 4686$ Å are reported.

F. N. MASTRUP

Space Technology Laboratories,
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Correlation of Metabolism and Energetics in Contracting Muscle

While it is obvious that the energy for muscular activity originates in biochemical processes, it remains to be demonstrated that measurable manifestations can be quantitatively accounted for in terms of specific chemical reactions. A certain amount of progress has been made in studying this question for the anaerobic iodoacetate-poisoned frog sartorius muscle in which a breakdown of phosphocreatine occurs from the earliest moment of activity, and in which during, for example, 12 tetani of 400 msec at 0°C, this remains the only demonstrable metabolic reaction. So far, the following relationships have been established.

In isometric experiments, the course of phosphocreatine breakdown during a tetanus has been investigated (Marechal and Mommaerts, in preparation); this is more rapid at first than later, and the quantities correspond reasonably to the "labile" and the "stable" part of the maintenance heat as distinguished by Aubert.

When in isotonic contractions the amount of work is varied by changing the load (Mommaerts, Marechal, Seraydarian, *Biochim. et Biophys. Acta*, in press), there is a correlation between work performance and phosphocreatine breakdown such that there is an "activation metabolism" of 0.45 $\mu\text{mole/g}$ per contraction, and a "work metabolism" of 1 $\mu\text{mole/9.1 mcal}$ of work, equal to a reasonable estimate of the summated reaction heats under the circumstances. This constitutes a chemical identification of the Fenn effect. On the other hand, there is no correlation of metabolism with shortening; this is ascribed to the circumstance that, as the muscle shortens, the maintenance metabolism diminishes to an extent which approximately compensates for the shortening metabolism.

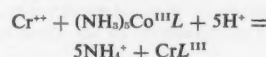
W. F. H. M. MOMMAERTS

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Electron Transfer among Transition Elements, Sudden Transition to Covalency, and the Chemical Consequences, Particularly for Taube's Reaction

CrCl_3 will not dissolve in water unless Cr^{++} is present in solution. It is suggested that this is because CrCl_3 is covalently bonded and that Cr^{++} exchanges electrons with the surface atoms and this causes them to become ionically bonded and to dissolve, because Cr^{III} forms only ionic complexes and Cr^{III} , only covalent.

The sudden change in bond type from ionic for Cr^{II} to covalent for Cr^{III} applies also to Taube's reaction



both for the oxidizing agent, Co^{III} , and for the reducing agent, Cr^{II} . The snapping of the Cr into a covalent state when the electron transfer occurs is possible only if acceptable groups are in positions ready to occupy the six octahedral positions, because of the Franck-Condon principle. This constitutes a barrier which appears to be rate-controlling for Taube's reaction, giving a high entropy of activation and a low heat of activation, as is observed. It also explains reasonably well the occurrence of hydrolysis of esters when used as ligands (L) and the relative magnitudes of the observed rates. It also explains why the alkyl esters hydrolyze with cleavage between the oxygen and alkyl group and explains a number of other details of Taube's reaction.

W. F. LIBBY

University of California, Los Angeles

Stability of Phonons in Bose Systems

Recent work on the quantum-mechanical many-body problem has shown that the low-lying excited states of a system are well described in terms of long-lived elementary excitations or quasi-particles. In most theoretical treatments these quasi-particles have a finite lifetime for decay even at absolute zero temperature, when collisions between quasi-particles are of negligible frequency. In liquid helium II, however, there appears to be an important difference. The energy-versus-momentum curve for the elementary excitations, as determined by slow neutron scattering, indicates that one phonon cannot decay into two or more phonons with conservation of energy and momentum. If we assume that the phonons are the only low-lying excitations of the system, we must conclude that the phonons are stable elementary excitations of the system.

In order to clarify the origin of this difference, we have studied the low-density Bose system by the method of Bogolyubov and have found that the phonons are unstable for short-range interactions. The decay time at long wavelengths is calculated to be independent of the interatomic forces, in agreement with the published

result for hard-sphere interaction. The origin of this independence is suggested by an examination of the Hamiltonian formulation of quantum hydro-dynamics as given by Kronig and Thellung. The simple cubic term in the kinetic energy of the fluid is the dominant nonlinearity at low density and long wavelengths, and it gives a decay time in agreement with the value calculated by the Bogolyubov method.

This work was performed while I was a visiting research associate at the Instituut voor theoretische fysica der Rijksuniversiteit, Utrecht, Netherlands.

MARK NELKIN

General Dynamics/General Atomic,
San Diego, California

Photosynthesis at Paired Wavelengths in Phycocyanin-Deficient Mutants of *Cyanidium caldarium*

Previous investigations of the monochromatic action spectrum for photosynthesis in *Cyanidium caldarium* demonstrated high photosynthetic activity at wavelengths (620 to 650 m μ) absorbed strongly by C-phycocyanin and low activity in spectral regions absorbed strongly by chlorophyll *a*. Present studies on the same strain, with paired wavelengths (far-red light paired with light of shorter wavelengths), reveal a typical Emerson enhancement effect, the action spectrum of enhancement corresponding to absorption by the C-phycocyanin.

In contrast with the wild type, ultraviolet mutants of *Cyanidium caldarium*, deficient in C-phycocyanin but possessing chlorophyll *a*, have photosynthetic action spectra which parallel closely the absorption of the latter pigment in the red portion of the spectrum. Low activity in the blue suggests absorption by photosynthetically inactive carotenoids. No enhancement of photosynthesis was observed in phycobilin-deficient mutants when a narrow band of far-red light (690 m μ) was paired with light of different shorter wavelengths. The implications of polychromatic enhancement in normal but not in phycocyanin-deficient strains of *Cyanidium* will be discussed.

KENNETH NICHOLS

Valparaiso University

F. T. HAXO

University of California, San Diego

Isolation and Properties of the Somatic Antigen of a Noncolicinogenic Variant of *Escherichia coli* K235

Colicine K is a bactericidal substance elaborated by *Escherichia coli* K235 and is an integral part of the Θ antigen of the bacillus. A mutant of the latter has been isolated which elaborates no colicine. We have undertaken to isolate the antigen of this bacillus and to compare its chemical and immunological properties with those of the parent. Any differences which these two substances might exhibit should be directly related to the antibacterial activity

of the O antigen of the colicinogenic bacillus.

The antigen of the noncolicinogenic variant was isolated from the culture medium by alcohol precipitation and was further purified by ammonium sulfate fractionation. The antigen so obtained is electrophoretically homogeneous. Freshly prepared antigens form a single band in agar diffusion tests. Upon further purification, however, an additional weak band appears—a fact which suggests that the antigen is somewhat labile. The lipocarbohydrate component of the antigen, obtained by phenol dissociation of the latter, contains rhamnose, glucose, galactose, and a hexosamine. Agar diffusion experiments reveal that colicine K and the O antigen of the noncolicinogenic variant are serologically indistinguishable—a fact which indicates a very close chemical resemblance. The two substances must differ, however, for one is bactericidal and the other is not. Whatever this difference may be, it must be directly related to the antibacterial property of the colicine. A study of the protein components of the two O antigens has been initiated and should reveal differences in chemical structure which can be correlated with the antibacterial properties of colicine K.

ERWIN RUDE

WALTHER F. GOEBEL

Rockefeller Institute

Observations of the Pacific Pilot Whale, *Globicephala sammonii*, in Nature

The cetaceans, a group of mammals containing the whales and dolphins, are of much interest today because of the emerging realization that the group contains species of unusually high mental capacity. Yet consecutive observations of these animals in their natural habitat are rare because of the secretive habits of the component species and the vast extent of the oceans in which they live. Therefore, observations on the life history of a single species of small whale, the Pacific pilot whale, are of interest even though most are short observations of a fragmentary nature. During the years 1954–60, pursuit of this species for display purposes allowed observation of many facets of behavior. The observations to be reported range over the subjects of swimming speed, reproductive habits and cycles, diving abilities, and a variety of kinds of social behavior. Included in this latter category are observations on hunting school formations, feeding schools, and what are called "loafing groups," protective behavior in which school members assisted injured school-mates, maternal behavior in which mother whales supported the bodies of dead young, attempts to protect young from capture, and a specialized assisted locomotion which allows newborn young to stay in formation with fast-moving adult schools.

KENNETH S. NORRIS

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Nova (WZ) Sagittae as a Binary Star

In recent years a number of cataclysmic variables have been found to be binary stars. Among these are Nova (DQ) Herculis (1934), Nova T Coronae Borealis (1866, 1946), and probably all stars of type U Geminorum (dwarf novae). A spectroscopic survey for binary characteristics among novae is being carried out with the prime focus spectrograph of the 200-inch telescope. The spectrum of Nova (WZ) Sagittae (1913, 1946) indicates it is a single-line spectroscopic binary with the unusually short period of 80 minutes and a total velocity range of 1400 km/sec. The large velocity range suggests that eclipses are a definite possibility.

ROBERT P. KRAFT

Mount Wilson and Palomar Observatories

Melting of Some Pure Elements at High Pressures

The effect of pressure, to 50 kbar, on the melting point of a number of pure elements has been determined. Particular effort has been devoted to the alkali metals. In addition to the melting point curves, solid-solid transitions of pure elements have been determined to 50 kbar. Of interest is the behavior of cesium and cerium. Melting points of cesium rise to a maximum, and there appears to be a near continuum of the boundary between molten cesium and solid cesium which has undergone high-pressure electron-shell collapse. Thus, at higher pressures there may be a critical point between a solid and a liquid where melting phenomena take place with little or no volume or latent-heat discontinuities. A critical end point between two solids has been found in cerium, where close-packed cerium and cerium undergoing electron-shell collapse grade continuously into each other.

G. C. KENNEDY

R. NEWTON

A. JAYARAMAN

University of California, Los Angeles

Release of Tectonic Strain by Underground Nuclear Explosions

The strong excitation of SH waves and other phenomenology associated with underground nuclear explosions suggest the hypothesis that pre-existing tectonic strain was released by the explosion. The pertinent evidence from the Rainier explosion is reviewed. A calculation of tectonic energy release is made for a simple model in which a spherical cavity is inserted in a pre-strained medium. It is tentatively concluded that, although tectonic release does occur, its magnitude is probably too small to affect the character of seismograms. Experiments are suggested which could provide the basis for a better evaluation of the hypothesis.

FRANK PRESS

CHARLES ARCHAMBEAU

California Institute of Technology

Diurnal Variation of K Indices of Geomagnetic Activity on Disturbed Days

In studying the diurnal variation of the K indices of geomagnetic activity from six observatories in moderately low latitudes and fairly evenly distributed in longitude, a local-time component showing a change of the yearly average over the 18 years 1940-57 has been found in the data for the 5 disturbed days of each month. These years cover nearly two sunspot cycles, and the change is similar for the two cycles. A change of the same general kind was found for the 10 quiet days of each month for the 9 years 1940-48. The change is such as might be occasioned by an increase or decrease in activity during the day, relative to that during the night, that accompanies in general an increase or decrease in the yearly average sunspot number with the cycle.

SETH B. NICHOLSON

Mount Wilson and Palomar Observatories

OLIVER R. WULF

U.S. Weather Bureau,
California Institute of Technology

Unusual Nucleic Acid Fraction from *Neurospora crassa*

An investigation of the distribution of nucleic acids in subcellular fractions of *Neurospora crassa* led to the isolation of a particulate component rich in RNA and containing a trace amount of DNA. The DNA content of this fraction is highest in actively growing young hyphae.

Deoxycholate treatment of these particles solubilizes all the DNA and a small amount of the RNA, leaving the bulk of the RNA and protein sedimentable. Phosphorus-32 incorporation studies indicate that the deoxycholate solubilized RNA is newly synthesized. Experiments employing chromatography with ECTEOLA, thermal denaturation, and nuclease digestion suggest that the deoxycholate-solubilized fraction contains a specific complex of DNA and RNA.

The possible role of this complex as an intermediate in the expression of genetic information will be discussed.

HERBERT M. SCHULMAN

University of California, San Diego

Rate of a Hapten-Antibody Reaction

The rate of the bimolecular reaction of a hapten and its specific antibody has heretofore not been measured directly. In these experiments, a purified rabbit antibody (generously donated by H. N. Eisen), specific for the 2,4-dinitrophenyl determinant, was reacted with the hapten 2-(2,4-dinitrophenylazo)-1-naphthol-3,6-disulfonic acid, disodium salt. A marked shift in the absorption maximum of the azo dye, from 580 to 485 m μ , occurs on binding to specific antibody near pH 7. This spectral change is due to a pK shift of the naphtholic OH group of the bound dye, and a

consequent protonation of this group on binding. This spectral property permitted a rate study of the hapten-antibody reaction to be made with a stopped-flow spectrophotometric instrument.

The assumption is made that the protonation of the dye is not rate-limiting. At an antibody concentration of $2.7 \times 10^{-6} M$ (antibody is bivalent and has a molecular weight of 1.6×10^5) and a hapten concentration of $2.0 \times 10^{-6} M$ in a buffer containing 0.02M phosphate and 0.15M NaCl, pH 7.4, at 25°C, the reaction was 57 percent completed within the dead time of the instrument, 0.004 second. Thereafter, the reaction followed second-order kinetics, with an apparent specific rate constant $k = 1 \times 10^5 \text{ l mole}^{-1} \text{ sec}^{-1}$. If the initial 57 percent of the reaction is assumed also to have followed second-order kinetics, its average k was $1 \times 10^5 \text{ l mole}^{-1} \text{ sec}^{-1}$. This distribution of k values possibly reflects heterogeneity in the antibody binding sites.

From measurements at 12.7°, 25.0°, and 40.0°C, an apparent activation energy of 6 kcal/mole was obtained, either from the more rapid initial parts or from the slower, directly measured parts of the reaction.

The extraordinary rapidity of this reaction (among the most rapid bimolecular reactions known) and its small activation energy indicate that little or no conformational rearrangements are required within the active sites of the antibody molecules on specific binding of the hapten.

JULIAN M. STURTEVANT

Yale University

LEON WOFSEY, S. J. SINGER

University of California, San Diego

Travel Time for Light from Distant Galaxies Related to the Riemannian Curvature of the Universe

Two methods can be used to determine the radius of curvature of the universe.

(i) In principle, galaxy counts determine the deviation of spatial volumes from $4/3\pi r^3$. However it can be shown that this method is insensitive even at the limit of the 200-inch telescope. (ii) Einstein's gravitational equations give the spatial curvature once the mean density of matter and radiation is known. This density can be found in principle from observations of the deceleration of the expansion of the universe. The deceleration can be found by comparing red-shift observations of nearby and very distant galaxies. The information is contained in the deviation from linearity of the red-shift, apparent magnitude relation for the galaxies, but unfortunately, an uncertain correction must be applied to the magnitude data before the deceleration can be found. Light from the galaxies now observed at the limit of the 200-inch with red shifts of $\Delta\lambda/\lambda_0 = 0.50$ started the journey toward the earth 4.1×10^9 years ago (if $H_0^{-1} = 13 \times 10^9$ years). We observe the properties of these galaxies as they were at this early time. Undoubtedly the stellar content of the galaxies has evolved in this immense time interval, and a change of brightness has occurred.

Exact calculations of the light travel time for galaxies of given red shifts are shown. A preliminary estimate of the evolutionary change of brightness of galaxies in this time is given, and the very tentative conclusions are reached that the deceleration parameter is $q_0 = +0.2$; that the universe is open and infinite, with a non-Euclidean hyperbolic geometry; that the radius of curvature is 17×10^9 light years (1.6×10^{26} cm); that the mean density of matter plus energy is 4×10^{-30} g/cm 3 ; and that the expansion will continue forever.

ALLAN SANDAGE

Mount Wilson and Palomar Observatories

Function of the Golgi Apparatus in the Exocrine Pancreas Cell

The various stages of the secretory cycle have been studied in the exocrine pancreas cell by making use of a clear-cut temporal sequence of these stages during embryonic development of the pancreas. The Golgi apparatus manufactures membrane material forming the surface membrane of precursor granules that develop into zymogen granules. The precursor granules show low opacity corresponding to a low concentration of solids. They move out from the Golgi apparatus, and then the secretory products are gradually concentrated in the granules. The membrane, therefore, is involved in this process of concentration and can be considered active membrane concentrating against a steep concentration gradient. The possibility of its contributing to the synthesis or chemical modification of the secretory products should be explored. This concentration takes place outside the Golgi region. Therefore, the Golgi region appears as a site of manufacture of the membrane but not as the actual site of the concentration of the secretory products.

F. S. SJOSTRAND

V. HANZON

University of California, Los Angeles

Does the Earth's Inner Core Behave as a Foucault Pendulum?

The lowest frequency peak (period 86 min) in the spectral analysis of gravimeter observations of the Chilean earthquake of 22 May 1961 has been ascribed to a rigid-body sloshing movement of the earth's solid inner core in its fluid surroundings. Initially the direction of such displacements would evidently be from the epicenter (latitude 38°S, longitude 73½°W) toward the earth's center. The gravimeter (located at 34°N, 118°W) is responsive only to the component of the core displacement along the vertical at the gravimeter. Because of the fluidity of the outer core it is suggested that the solid inner core is decoupled from the rotating earth so that it vibrates in a fixed plane (or at least in a plane rotating only slowly) like the classical Foucault pendulum. If so, the excitation of the gravimeter would be

relatively high during about half the day and low during the remaining portion. For the specified geometry, the mean square value of the excitation for the favorable interval is 13-fold greater than that for the succeeding unfavorable interval. The original observational data were taken at 1-minute intervals for a period of 4½ days following the earthquake. These data were regrouped to form a time series composed only of favorable intervals and one composed only of unfavorable intervals. These series were each analyzed spectrally in accordance with previously described techniques. In these two analyses, the amplitudes of all peaks except that associated with the supposed Foucault pendulum mode of the inner core should remain in constant ratio, but the amplitude of the latter should be much enhanced during the favorable period. The results and significance of these analyses will be discussed.

L. B. SLICHTER
J. C. HARRISON

University of California, Los Angeles

N. F. NESS

Goddard Space Flight Center

Mode Conversion and Dissipation of the Earth's Free Oscillations

The fundamental spheroidal mode of the earth was excited by the Chilean earthquake of 1960. Spectral analysis of strain recordings shows that this mode is split, and at least four of the five possible lines can be observed. The average spacing of these lines is in good agreement with the expected effect of the rotation of the earth. The intensity of these lines has been studied as a function of time in an attempt to measure the dissipation function of the earth. The two most intense lines, corresponding to surface harmonics $P_2^{-1}(\cos \theta) \exp(-i\phi)$ and $P_2^1(\cos \theta) \exp(i\phi)$, have apparent rates of decay that are significantly different. The weak central line corresponding to the zonal harmonic $P_2(\cos \theta)$ actually shows a steady increase in intensity with time over a 20-day interval following the earthquake.

In view of these facts, we believe that the apparent rates of decay are controlled by the transfer of energy between adjacent spectral lines. Furthermore, the data indicate that energy is transferred from the tesseral harmonic modes to the zonal mode.

These results are based on a single example of the excitation of the earth's free oscillations.

STEWART W. SMITH

California Institute of Technology

Terrestrial Age of Stony Meteorites

It is generally assumed that stony meteorites are subject to weathering and disintegration in a relatively short time after fall. Cosmic-ray-produced radioactivities provide a possible means of determining the time elapsed since a meteorite fell. Radiocarbon proves to be a useful isotope

for this purpose. We have measured the radiocarbon content in five meteorites that have fallen during the past few decades. This content shows variations of less than 20 percent. In the case of finds of unknown time of fall, however, the radiocarbon content was found to be much smaller. The terrestrial age calculated from these measurements on stony meteorites ranges from a few thousand years to more than 20,000 years, the limit of the method. This means that stony meteorites are preserved longer on the surface of the earth than we had anticipated.

HANS E. SUESS

University of California, San Diego

Isotopic Composition of Barium and Cerium in Stone Meteorites

Reynolds observed that in addition to the special anomaly due to the decay of ^{138}Ba to ^{138}Xe there was a more general anomaly in the abundances of the isotopes of xenon. This suggested that other variations of this kind might possibly be observed. Barium is near xenon in the periodic system, has a similar range of isotopes in mass numbers, and thus might show anomalies of this kind. An investigation of three meteorites showed variations in the isotopic abundances relative to terrestrial samples. This appears to indicate a very substantial synthesis of elements during the formation of the solar system, or a lack of complete mixing of previous synthetic products during the formation of the solar system.

SHUNJI UMEMOTO

University of California, San Diego

Impulse Traffic in the Optic Nerve of Decapod Crustacea

Single unit recording from axons in the "optic nerve" of the crab, *Podophthalmus vigil* (Fabricius), has shown that a large proportion of these axons are essentially interneurons of the central nervous system, carrying information to as well as from the optic ganglia in roughly equal numbers. This finding confirmed and extended previous preliminary experiments on a variety of decapods (Waterman and Wiersma, in preparation). From the eye, integrated information is carried by a variety of fiber types, distinguished according to (i) the area of the visual field to which the fiber responds, ranging from the whole eye down to fairly small areas; (ii) the type of stimulation eliciting maximal responses, ranging from fast-moving large objects to changes in the intensity of stationary illumination; (iii) the amount of contrast necessary for maximal stimulation; and various other factors, all of which combine to give each interneuron specific properties.

Fibers carrying information to the eye respond to (i) visual stimulation of the heterolateral eye, many with characteristics similar to those outlined above; (ii) hair and/or joint stimulation of different parts

and extents of the body; and (iii) visual as well as tactile and proprioceptive stimulation, in various combinations. The optic nerve of Decapoda must hence be considered a connective between parts of the brain. Since animals in which both eyes are cut off still respond to nonvisual inputs, information of which is normally transmitted by interneurons toward the eyes, it is evident that this information is integrated in the brain as well as in the optic ganglia. It is therefore strongly indicated that, at least in the crustacean central nervous system (CNS), not only is the sensory input subjected to simultaneous parallel analysis, by different interneurons, as has been shown previously (Wiersma, 1958), but also parallel integration of this already analyzed information takes place, in different parts of the CNS. This would provide for functional integrity even when large parts of the CNS are not able to function for one reason or another.

C. A. G. WIERSMA

California Institute of Technology

TALBOT H. WATERMAN

Yale University

BRIAN M. H. BUSH

University of Cambridge

Stereochemistry of Fumagillin

Dihydroalcohol-I (structure I) is obtained from fumagillin by hydrolysis and reduction [D. S. Tarbell *et al.*, *J. Am. Chem. Soc.* **82**, 1005 (1960)] (Fig. 1). By assigning the seven-carbon side chain at carbon-2 to the equatorial position, it is possible to deduce the stereochemistry of the cyclohexane ring in I; the results are in agreement with those obtained by McCorkindale and Sime (*Proc. Chem. Soc.*, in press) from x-ray analysis. Reduction of I yields the tetrahydroalcohol (structure II), and dehydration of the latter (II, $R = \text{COCH}_3$) with thionyl chloride-pyridine gives two isomeric anhydro derivatives, with an exocyclic methylene and a 1,6-double bond, respectively. Oxidation of the 1,6-isomer gives the 1,6-epoxide, and this is converted by hydride reduction to the tetrahydroalcohol (II). The hydroxyl at position 1 is therefore axial, and hence

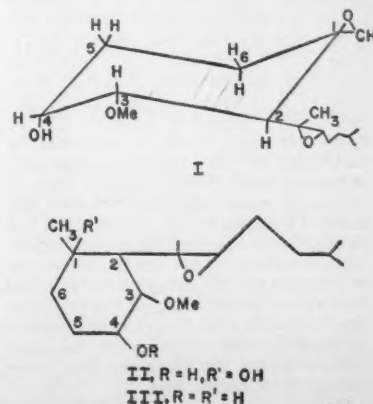


Fig. 1.

the oxygen of the spiroepoxide in I must be axial. Deoxytetrahydroalcohol (structure III) may be prepared from both anhydro derivatives by reduction. Treatment of III with phosphorus oxychloride-pyridine eliminates the 4-hydroxyl, with formation of a 3,4-double bond. A trans diaxial elimination may be assumed, and hence the 4-hydroxyl and the 3-hydrogen are axial; the 3-methoxyl is therefore equatorial. Dihydroalcohol (I) has the same configuration as III at positions 2, 3, and 4, and therefore the stereochemistry of I is as represented. The stereochemistry of cyclizations of derivatives of II and III, and of model compounds, to perhydrobenzofurans, with loss of methoxyl [D. S. Tarbell *et al.*, *J. Am. Chem. Soc.* **82**, 1005 (1960); *ibid.*, in press], will be considered.

J. R. TURNER, D. S. TARBELL
University of Rochester

Evidence for Convection in the Earth's Crust and Upper Mantle

A world-wide network of rifts characterized by concentration of earthquake epicenters and low seismic speeds for the mantle material has been proposed by several investigators to account for tectogenesis and continental drift. These features presumably mark the location of upwelling hot mantle material, which then spreads laterally, causing great horizontal displacements of the crust. When such an upwelling current happens to be under the ocean, it generates a broad topographic rise with high heat flow along its crest. When it happens to come under a continent, rifting of the land mass occurs, with outflow of lava and thinning of the crust.

These concepts are applied to the East Pacific Rise. Its oceanic portion has been investigated seismically, geothermally, and topographically. Where it plunges under North America, it caused rifting of the Gulf of California, recent volcanism of the Basin and Range Province, and great lateral east-west displacements in the ocean floor along the Mendocino and Murray faults. The upper mantle and crust moved westward by the addition to the ocean floor of strips of sima several hundred miles long, which show up as north-south magnetic anomalies between latitudes 25° to 50° N and extend from the continental slope to 150° west longitude. The western edge of the upwelling mantle current is defined by heat-flow measurements at sea. The eastern edge lies probably at the Rocky Mountain Front, as suggested by the change in character of magnetic time variations, which indicate shallow depth to electrically conducting, and therefore hot, material between Yuma, Arizona, and Las Cruces, New Mexico. Additional experimental evidence to test this hypothesis can be obtained by measuring geothermal heat flow west of the Rio Grande Valley and by simultaneously recording three components of magnetic time variations on the ocean floor at several stations along lines crossing the East Pacific Rise.

VICTOR VACQUIER
University of California, San Diego

Meteoritic and Terrestrial Abundances of the 14 Rare-Earth Elements, Lanthanum to Lutetium

Accurate abundance values for the 14 rare-earth elements, lanthanum to lutetium, are necessary in order to establish empirical relationships among the abundances of the chemical elements formed in nucleosynthesis. Because of the high degree of chemical similarity of the rare earths, these elements are assumed to have migrated through time and space as an entity.

By using the highly sensitive technique of neutron activation analysis, the concentrations of these elements have been determined in two chondritic stones, two achondritic stones, two iron meteorites, and a fresh basalt sample from the Kilauea volcano in Hawaii. After a 2-hour irradiation in a Triga reactor at a flux of 1.8×10^{13} neutrons/cm²/sec, the 5-g meteoritic or basaltic samples were subjected to radiochemical and ion-exchange techniques in order to decontaminate and to separate individually the 14 elements.

Some of the observations from this study are noted. (i) The abundances of the odd- and even-A atomic masses in the stone meteorites decrease rather smoothly and with nearly identical slopes for increasing A. (ii) Abundances of the even-A masses are about 4 times greater than the adjacent odd-A masses. (iii) Absolute abundances in achondritic meteorites were about 10 times greater than in chondritic meteorites. (iv) The ratio of concentrations in the iron to that in stony meteorites was about 10^{-4} . (v) Isotopic ratios of five of the elements in these meteorites agree with terrestrial values. (vi) Relative concentrations in the Kilauea basalt agree well with relative contents in other terrestrial matter.

Implications of these findings will be discussed.

ROMAN A. SCHMITT
General Dynamics/General Atomic, San Diego, California

Double Visual Learning in Split-Brain Monkeys

The demonstrated ability of split-brain monkeys to perform mutually contradictory visual discriminations raised the question of whether these conflicting processes might be carried on simultaneously, in parallel, in the separated hemispheres. To test this, an apparatus was designed that employs polarized light filtration to make the two eyes see different things at the same point in space. It enables one to present the subject with different, even contradictory, tasks simultaneously, one visible to each eye, and to test thereby the functional independence of the two separated hemispheres. This double learning technique has also proved useful in further analysis of the neural mechanisms of visual perception.

A study with simultaneously presented contradictory tasks has shown that the surgically separated brain halves may learn side by side at the normal rate, as if they were quite independent. But there are more

occasions when one hemisphere learns normally while the other is slower or fails to learn. Competition between the two halves of the brain appears to take place nearer the motor level of integration. Frequently there is a preferential contralateral coupling, such that eye and limb centers are in the same half of the brain, the right eye learning when the left hand is active and vice versa. Tests, in which the experimenter has full control over eye-hand combinations which the subject is allowed to use, show that ipsilateral eye-hand pairs may become efficient at learning and recall of visuomotor tasks. This occurs even though, under the experimental conditions, the main motor centers for the limb involved are in the opposite hemisphere and are surgically separated at all higher levels from the centers receiving the visual information.

C. B. TREVARTHEN
California Institute of Technology

Bristle Pattern of *Drosophila*

The bristle pattern of *Drosophila* may be estimated to have been present—probably originally with more bristles than are now found—for at least 10^8 generations. Natural selection has evidently stabilized this pattern, which is now remarkably constant in wild-type flies—that is, it is modified only slightly or not at all by environmental influences.

Various mutant genes are known which remove certain bristles or add new ones, usually, at least, ones that are known in related Diptera and that may be supposed to have been present in the ancient ancestral pattern. These new patterns, caused by mutant genes, are regularly quite variable, in response both to modifying genes and to such environmental influences as nutrition and temperature.

There is little obvious regularity about the reduced patterns due to different mutant genes. The two dorsocentrals are usually unaffected or both affected, as are two scutellars and the two anterior orbitals. Otherwise no rules of general applicability appear. A study has now been completed that indicates the same conclusion for modifying genes. Each bristle (or each pair in the cases of the dorsocentrals, the scutellars, and the two anterior orbitals) has its own set of controlling genes. The members of such sets may affect other bristles, but there are no clear rules as to which others are likely to be affected by any such gene.

A. H. STURTEVANT
California Institute of Technology

Termination of Immunological Tolerance to a Protein Antigen

Immunological tolerance produced by injection of neonatal rabbits with bovine serum albumin (BSA) was lost following injection of the tolerant rabbits with certain serologically related albumins. The more distantly related the albumin was, the greater was its ability to break the tolerant state. Also, the breaking of the tol-

erant state was inhibited if soluble BSA was injected with the related albumin. The injection of the related albumin in the form of Freund's adjuvant was less effective than the injection of soluble albumin. Injection of acetylated, heat-denatured, picrylated, and pepsin-treated BSA not only failed to break the tolerant state but also failed to elicit antibody to the altered portion of the molecule.

WILLIAM O. WEIGLE
*Scripps Clinic and Research
Foundation, La Jolla, California*

Further Studies in Learning with "Split Brain" Cats

Cats have been trained to perform a conditioned response (flexion of forepaw to flashing light) the primary motor control of which is on the left side of the brain, while sensory input has been restricted to the right side. Midline section of neural cross connections was performed in progressive stages. The most complete bisection to date includes division of optic chiasm; corpus callosum; anterior, posterior, habenular, hippocampal, and tectal commissures; mass intermedia; and the tegmentum through the rostral third of the pons. The conditioned response survived these procedures and was also established in naive animals after surgery.

Removal of visual and motor cortices and other structures suspected of playing a critical role in conditioning have been combined with the afore-mentioned procedures. Results at present indicate that the conditioning process may entail development of central, cortically organized facilitatory sets rather than formation of new connections between cortical receptor and motor centers, as has been classically postulated.

Related experiments have been carried out on cats to determine the role of midline structures in the performance of perceptual brightness and pattern discriminations. The two visual stimuli to be discriminated were projected, one to the right hemisphere and the other to the left hemisphere, by using colored light sources and training goggles with color filters on animals with the optic chiasm sectioned. Brightness discriminations under these conditions survive midline section of corpus callosum and of anterior, posterior, habenular, hippocampal, and tectal commissures, indicating that for brightness perception at least, the tegmentum may play a critical role. Pattern discriminations are presently being run in a similar manner.

THEODORE J. VONEIDA
California Institute of Technology

Organic Matter in the Atmosphere as Energy Supply for Lightning

All plants continuously produce small amounts of volatile organic matter, such as terpenes and esters, which become polymerized in the air under the influence of sunlight and then, as polymers, are very stable against further decomposition. It was suggested that these materials not only are the source of atmospheric hazes but also form the parent material for petroleum formation. A major difficulty with this hypothesis is that there should be much more oil and asphalt in the crust of the earth than there is. It is now suggested that this organic matter in the atmosphere can decompose with the formation of positive charges, giving rise to the fair-weather current in the atmosphere and to the high voltages generated in thunderclouds. Most of this positive charge is concentrated in the surface of the cloud, where also most of the organic matter accumulates. When the total energy available in this volatile plant material is calculated, it is found to agree very closely with the total energy in all lightning bolts. The distribution of thunderstorms also closely parallels the density and activity of the vegetation: most thunderstorms occur in the tropics and, during the summer months, in temperate regions, whereas the oceans, deserts, and polar regions are practically free of them. It is suggested that this organic matter, when it accumulates further, can be the source of energy for tornadoes.

F. W. WENT
Missouri Botanical Garden

Symposium on Particles and Fields in Space

Gordon J. F. MacDonald, Chairman

Spectrum of Hydromagnetic Waves in the Exosphere

Three wave fronts, propagating vorticity about the line of force, two-dimensional divergence transverse to the line of force and the longitudinal component of velocity carry a hydromagnetic disturbance through a uniform electrically conducting fluid in a magnetic field. The propagation of vorticity is one-dimensional, and there is no geometrical attenuation. It is suggested that this mode predominates in transferring magnetic storm energy. The propagation of the longitudinal component velocity is almost one-dimensional but is heavily damped at high frequencies. In a gravitational field, the medium is no longer uniform, and at low frequencies the

modes are coupled in a complicated way. The influence of gravity is characterized by the frequency of oscillation of a small parcel of fluid when displaced from its zero-order position in the gravitational field. For parallel magnetic and gravitational fields the vorticity mode is still separable, and gravity leads to anisotropic dispersion in the other modes. The propagation at low frequencies is no longer cylindrically symmetrical if the lines of force are at an arbitrary angle to the direction of gravity. Detailed investigations of the influence of the gravitational field on hydromagnetic wave propagation is carried out for the case where the sound velocity is small as compared to the Alfvén wave velocity.

GORDON J. F. MACDONALD
University of California, Los Angeles

Effect of Hydromagnetic Waves on the Lifetime of Van Allen Radiation Protons

The effect of hydromagnetic waves upon the motion of charged particles trapped in the geomagnetic field is studied. Application is made to the proton component of the Van Allen radiation belt. It is shown, in agreement with the suggestion of Welch and Whitaker, that hydromagnetic waves of low frequency and amplitude are able to account for the rapid decrease in proton flux that delimits the outer edge of the inner zone of the Van Allen radiation belt. Both the location of the boundary of the inner zone and the ratio between the proton fluxes in the inner and outer zones are obtained. It is found that near 2 earth radii from the earth's center, the maximum energy of the trapped protons decreases with geocentric distance as r^{-11} .

A. J. DRAGT
University of California, Berkeley

Elementary Collision Processes in the High Atmosphere

Many high-atmosphere phenomena—for example, the collision electron density in the E layer—depend on collision rates which are not readily measurable in the laboratory. This paper lists a number of such collision processes and briefly reviews the presently available theoretical procedures for estimating their rates.

EDWARD GERJUOY
*E. H. Plesset Associates,
San Diego, California*

128th Annual Meeting: Program Summary

Physics

Wednesday 27 December

Physics Research in the Rocky Mountain Area. Part I, arranged by Wayne B. Hales, Brigham Young University, who will preside. Molecular excitation of air by nuclear explosions, D. Westervelt and H. Hoerlin. Detection method for nuclear explosions in space, D. Westervelt and H. Hoerlin. Energy deposition spectrum of gamma rays in very large organic scintillators, M. Van Dilla. Magnetic resonance research, John Hale Gardner. High pressure physics, Tracy Hall. Solid state research at the Martin Company, William J. Veigle. Recent progress in wide-angle optical diffraction, W. B. Hoerlin, D. H. Brownell, H. J. Woodford, W. T. Silfvast, and Franklin S. Harris, Jr. Laboratory studies on heterogeneous ice nucleation, R. G. Layton, D. C. Sparks, and Franklin S. Harris, Jr.

Part II: Mario Iona, University of Denver, presiding. Scattering of an elastic disturbance by a random medium, Frank Hadsell. The University of Colorado cyclotron: department of physics: (i) general description and operational experiences during startup, D. A. Lind, J. J. Kraushaar, M. Rickey, and W. R. Smythe; (ii) magnetic field measurements and orbit calculations, D. A. Lind, M. Rickey, B. Bardin, and C. Hoot; (iii) radio frequency system, P. W. Allison, P. Henning, W. R. Smythe, and D. C. Witte. An atomic definition for the unit of time, John M. Richardson. Nuclear magnetic relaxation, Burton H. Muller. Relationship problems of altimetry, John C. Bellamy. Recent research in biochemistry: (i) studies on selenium; (ii) metabolism of lipids, Robert McColloch.

Physicists' Luncheon. Joint session of AAAS Section B-Physics and Sigma Pi Sigma, arranged by Mario Iona, University of Denver. Stanley S. Ballard, president, Sigma Pi Sigma, presiding.

On doing research with space probes and satellites, Charles P. Sonett, chief, Lunar and Planetary Sciences Program, National Aeronautics and Space Administration.

Thursday 28 December

Interdisciplinary Symposium in the Physical Sciences: Physics of the Upper Atmosphere. Joint program of AAAS Sections B-Physics and D-Astronomy, cosponsored by the American Astronomical Society, the American Geophysical Union, the American Meteorological Society, and Sigma Pi Sigma. Arranged by Stanley S. Ballard, University of Florida, and Alan H. Shapley, National Bureau of Standards, Boulder Laboratories, Boulder, Colorado. Alan H. Shapley will preside. The atmosphere above 50 kilometers, William G. Stroud. Atmospheric winds and diffusion coefficients in the 100-kilometer region, Edward Manning. The invisible aurora, Franklin E. Roach. Scatter sounding of the high atmosphere, Von R. Eshleman.

American Astronautical Society

Program Chairman: Marvin Pitkin, Martin-Denver, Denver, Colorado.

Thursday 28 December

A guided tour of the Martin Company Research and Development Facility, Waterton, and an organization meeting of the society's Rocky Mountain section of American Astronautical Society, arranged by Raymond Wiltshire, Advanced Missile and Booster Department, Martin-Denver, will be held.

Friday 29 December

Manned Lunar Flight, Session I: Lunar Space Craft. Program of the American Astronautical Society, cosponsored by the National Aeronautics

and Space Administration and arranged by George W. Morgenthaler, Space Mathematics Laboratory, Martin-Denver. George M. Low, National Aeronautics and Space Administration, presiding. Propulsion capability for lunar missions, Yuan C. Lee. Lunar space craft designs, George R. Arthur. Lunar navigation and guidance, Wilhelm Elfers. Communication and power supply aspects of lunar missions, Frederick W. Brown. Lunar landing problems, William Duke. Re-entry from lunar missions, Arthur Kantrowitz.

Session II: Physiological Factors in Manned Lunar Flight. Joint program of the American Physiological Society and the American Astronautical Society. Arranged by Robert E. Smith, University of California, Los Angeles. Loren D. Carlson, University of Kentucky, presiding. Neurophysiological aspects of space flight, W. D. Winters. Hemodynamic evaluation at null gravity, Nello Pace. Panel: Space physiologists: Their role, availability, and training; Loren D. Carlson, chairman. Panel Members: William Purdy, The Martin Company, Denver; J. H. U. Brown, National Institutes of Health; and Robert E. Smith, University of California, Los Angeles.

Session III: Lunar Environment Basing. Program of the American Astronautical Society, cosponsored by the National Aeronautics and Space Administration. Arranged by George W. Morgenthaler, Space Mathematics Laboratory, Martin-Denver. Walter Orr Roberts, National Center for Atmospheric Research and High Altitude Observatory, presiding. Lunar topography, E. Whitaker. Lunar basing, John Denike. Lunar missions, Kraft Ehrlicke. Lunar exploration vehicles and equipment, Jack Froehlich.

Luncheon. Alfred Mayo, National

Program notes for some sections ("Chemistry" and "Mathematics and Related Programs") appeared in the 27 October issue of *Science*, page 1376. Reports on other sections will appear in succeeding issues.

On page 1442 of this issue appears a coupon which readers can mail in to obtain hotel reservations for the annual meeting.

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Aeronautics and Space Administration, presiding. Strategic implications of manned lunar flight, Herman Kahn, Rand Corporation, Santa Monica, California.

Banquet. Marvin Pitkin, Advanced Technology, Martin-Denver, presiding. The national and international significance of the lunar exploration program, Hugh L. Dryden, National Aeronautics and Space Administration, Washington, D.C.

Astronomy

Wednesday 27 December

Vice Presidential Address of Section D. Frank Bradshaw Wood, Flower and Cook Observatory, University of Pennsylvania, Philadelphia, presiding. Speaker: Nicholas U. Mayall, Lick Observatory, Mt. Hamilton, California.

American Astronomical Society

All program sessions of the AAS are jointly sponsored by AAAS Section D—Astronomy. Sessions for contributed papers will be held on Wednesday 27 December (morning and afternoon) and Friday 29 December.

Thursday 28 December

A demonstration of the public programs of Chamberlin Observatory, University of Denver, will be held.

Society Dinner. Speaker, Walter Orr Roberts, National Center for Atmospheric Research and High Altitude Observatory, Boulder, Colorado.

Friday 29 December

Magnetic Fields in the Solar System.

Program of the American Astronomical Society, cosponsored by AAAS Section D—Astronomy. Arranged by R. Grant Athay, High Altitude Observatory, Boulder, Colorado, who will preside. The sun's magnetic field, Horace W. Babcock. Recent measurements of the solar interplanetary magnetic field, J. P. Heppner. Interplanetary magnetic fields as inferred from energetic solar particles and galactic cosmic rays, Leverett Davis, Jr. Jupiter's magnetic field, J. W. Warwick.

Saturday 30 December

Contributed Papers. Concurrent Session for Contributed Papers.

Forthcoming Events

November

14-16. American Meteorological Soc., Tallahassee, Fla. (Executive Secretary, AMS, 45 Beacon St., Boston 8, Mass.)

14-16. Electronics Research and Engineering, 15th annual, Boston, Mass. (L. Winner, 152 W. 42 St., New York 36)

14-17. Corrosion in Nuclear Technology, symp., Paris, France. (European Federation of Corrosion, Société de Chimie Industrielle, 28 rue St. Dominique, Paris)

14-18. Puerto Rico Medical Assoc., Santurce. (J. A. Sanchez, P.O. Box 9111, Santurce)

15-17. Eastern Analytical Symp., New York, N.Y. (A. Rekus, EAS, Research Dept., Baltimore Gas & Electric Co., Pratt St., Baltimore, Md.)

15-18. Action for Mental Health, 11th annual, Miami Beach, Fla. (H. Milt, Natl. Assoc. for Mental Health, 10 Columbus Circle, New York 19)

15-18. Society of Naval Architects and Marine Engineers, annual, New York, N.Y. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

16-18. American Psychiatric Assoc., Milwaukee, Wis. (J. D. McGucken, 756 N. Milwaukee St., Milwaukee 2)

16-18. Etiology of Myocardial Infarction, intern. symp. (by invitation), Detroit, Mich. (T. N. James, Section on Cardiovascular Research, Henry Ford Hospital, Detroit)

16-18. Southern Thoracic Surgical Assoc., Memphis, Tenn. (H. H. Seiler, 517 Bayshore, Blvd., Tampa 6, Fla.)

16-19. American Anthropological Assoc., Philadelphia, Pa. (S. T. Boggs, 1530 P St., NW, Washington, D.C.)

17-18. Southern Soc. for Pediatric Research, Atlanta, Ga. (W. G. Thurman, Dept. of Pediatrics, Emory Univ. School of Medicine, Atlanta)

17-31. National Soc. for Crippled Children and Adults, annual conv., Denver, Colo. (NSCCA, 2023 W. Ogden Ave., Chicago 12, Ill.)

19-22. International College of Surgeons, Western regional, San Francisco, Calif. (W. F. James, 1516 Lake Shore Drive, Chicago 10, Ill.)

22-27. Automation and Instrumentation, 5th conf., Milan, Italy. (Federezione delle Societa Scientifiche e Tecniche di Milano, via S. Tomaso 3, Milan)

22-1. Radioisotopes in Animal Biology and the Medical Sciences, conf., Mexico City, D.F. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

23-25. Central Assoc. of Science and Mathematics Teachers, Chicago, Ill. (J. Kennedy, Indiana State Teachers College, Terre Haute)

24-25. American Soc. of Animal Production, Chicago, Ill. (C. E. Terrill, Animal Husbandry Research Div., U.S. Dept. of Agriculture, Beltsville, Md.)

24-25. National Council for Geographic Education, Philadelphia, Pa. (L. Kennamer, Dept. of Geography, Univ. of Texas, Austin)

25-26. American College of Chest Phy-

sicians, annual interim session, Denver, Colo. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago 11, Ill.)

26. Medical Aspects of Sports, 3rd natl. conf., Denver, Colo. (F. V. Hein, AMA Committee on the Medical Aspects of Sports, 535 N. Dearborn St., Chicago 10, Ill.)

26-1. American Soc. of Mechanical Engineers, winter, New York, N.Y. (L. S. Dennegar, ASME, 29 W. 39 St., New York, N.Y.)

26-1. Radiological Soc. of North America, annual, Chicago, Ill. (R. P. Barden, 713 E. Genesee St., Syracuse 2, N.Y.)

27-28. Agricultural Meteorology, 4th conf., St. Louis, Mo. (K. C. Spengler, American Meteorological Soc., 45 Beacon St., Boston 8, Mass.)

27-29. American Soc. of Hematology, annual, Los Angeles, Calif. (J. W. Rebuck, ASH, Henry Ford Hospital, Detroit 2, Mich.)

27-30. American Medical Assoc., Denver, Colo. (F. J. L. Blasingame, 535 N. Dearborn, Chicago 10, Ill.)

27-30. American Soc. of Agronomy, jointly with Crop Soc. of America, Council on Fertilizer Application, and Soil Science Soc. of America, St. Louis, Mo. (ASA, 2702 Monroe St., Madison, Wis.)

27-30. Entomological Soc. of America, Miami, Fla. (R. H. Nelson, 4603 Calvert Rd., College Park, Md.)

29-1. Communication Wires and Cables, symp., Asbury Park, N.J. (H. Kingsley, U.S. Army Research and Development Laboratory, Fort Monmouth, N.J.)

29-1. Western Surgical Assoc., San Francisco, Calif. (W. W. Carroll, 700 N. Michigan Ave., Chicago 11, Ill.)

30. American Geographical Soc., New York, N.Y. (C. W. Bastable, Columbia Univ., New York 27)

30-1. Conference on Graduate Medical Education, Philadelphia, Pa. (P. Nemir, Jr., Dean, Graduate School of Medicine, Univ. of Pennsylvania, Philadelphia)

30-1. Vehicular Communications, Minneapolis, Minn. (J. Kahnke, Minneapolis-Honeywell, Aero Div., 1541 Edgewater Ave., St. Paul 13, Minn.)

30-2. Purest Substances in Science and Technology, intern. symp., Dresden, Germany. (Sekretariat, Chemische Gesellschaft in der Deutschen Demokratischen Republik, Unter den Linden 68/70, Berlin W.8, Germany)

December

1. Symposium on Insulin, New York Diabetes Assoc., New York, N.Y. (New York Diabetes Assoc., 104 E. 40 St., New York 16)

1-2. Linguistic Circle of New York, 7th annual conf., New York, N.Y. (L. Urdang, Random House, Inc., 501 Madison Ave., New York 22)

2. International College of Surgeons, intern. executive council, Chicago, Ill. (H. E. Turner, 1516 Lake Shore Dr., Chicago)

2. New York State Registry of Medical Technologists, annual seminar, New York, N.Y. (S. H. Keeling, 1719 Midland Ave., Syracuse, N.Y.)

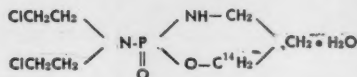
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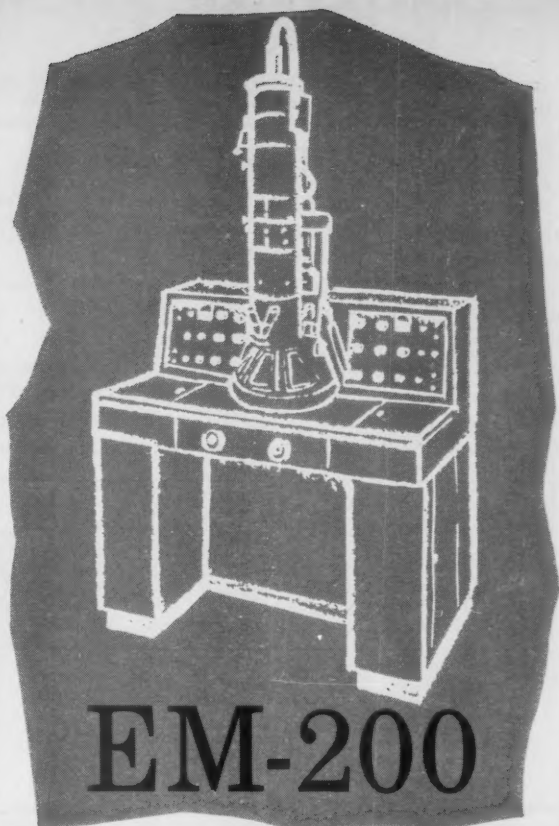
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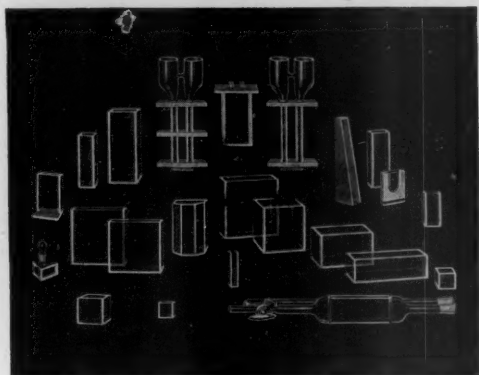
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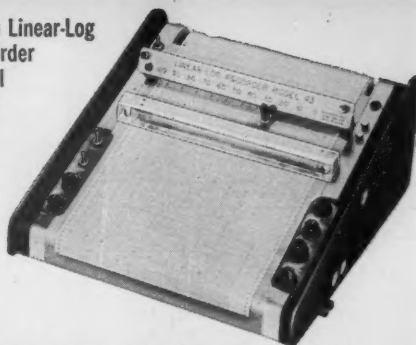


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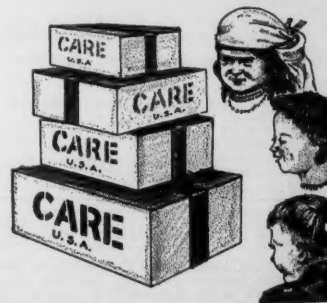
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The new 'block shape'  passband in the Visible Spectrum Filters enables the user to obtain the greatest degree of spectral purity.

If the filter you require is not available in stock, normal delivery time is within thirty to thirty-five days.

Standard filter sizes are 1" x 1" and 2" x 2"; other sizes and shapes are available on special order. Write for your copy of our new filter brochure.


Engineers and scientists — investigate challenging opportunities with Baird-Atomic. Write Industrial Relations Department.



BAIRD-ATOMIC, INC.

33 university road · cambridge 38, mass.

Visible Spectrum

- 4000Å - 8000Å
- New block shape  passband
- Absorption filters and/or evaporated blocking components provide for maximum blocking, reduced thickness, and improved signal-to-noise ratio
- Transmission outside of passband: under 0.1%
- Half bandwidths from 4.8Å to 1600Å
- Total transmission from fully blocked filter up to 70%
- Blocking — complete on low side — high side blocking to at least 8000Å (Additional blocking at extra cost)

Ultraviolet Spectrum

- 2100Å to 3400Å and 3900Å to 3999Å

ADVANCED OPTICS AND ELECTRONICS... SERVING SCIENCE

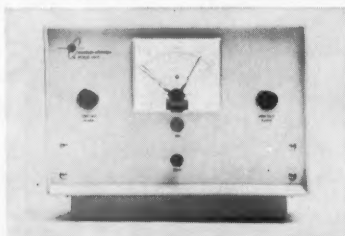


NUCLEAR REVIEWS

from
NUCLEAR-CHICAGO

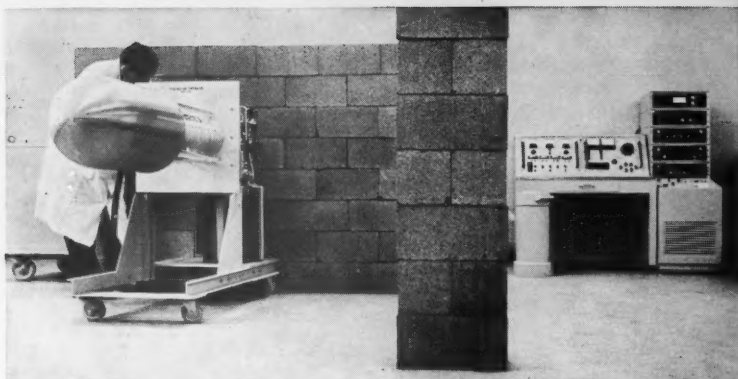
THE LABALARM— A NEW AREA MONITOR

The chirping, buzzing, or clanging alarm designed into a monitor is useful for a variety of laboratory chores. Applications include positive indication of the end of radiation exposure in gaging or radiography, accurate indication of dose received by personnel working with sources, development of radiation isodose curves, and accurate monitoring of background radiation in low-level counting rooms when used with a chart recorder.



The new 1629 Labalarm not only protects against radiation hazard, it is also an instrument with practical features for everyday use even in laboratories where no personnel hazard exists.

The Labalarm is a precision rate-meter with provision for connecting a remotely positioned scintillation, G-M, neutron, or alpha detector. An audible alarm tone automatically sounds when the meter needle comes in contact with a high or low level setting. Each setting is variable over a range of zero to 20,000 cpm. Each setting has its own signal light—red for high and amber for low. Write for complete specifications.



THE COMPLETE NEUTRON LABORATORY

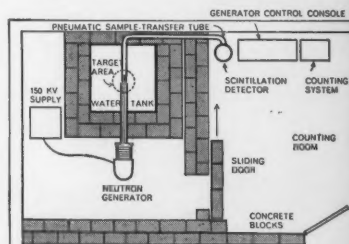
The pooling of resources by Texas Nuclear Corporation and Nuclear-Chicago Corporation brings to the scientific community an expanded, improved source for advanced nuclear systems. An outstanding example is the laboratory shown here which consists of a neutron generator, sample-transfer control, scintillation detector, and counting instrumentation.

The Texas Nuclear neutron generator is a compact, inexpensive system for generating controllable, intense yields of fast and slow neutrons. The instrument produces a fast neutron yield of 4×10^{10} neutrons per second and a thermal flux of 5×10^8 neutrons per second with an appropriate moderator. The standard Model 9500 accelerator can deliver over 1.0 milliamperes of beam current. The Model 9501 is offered for those applications in which it is desired to pulse the ion beam to obtain neutron bursts of known width, amplitude, and frequency. Both models are equipped with an ion vacuum pump. High voltage, vacuum, focus, gas flow, and solenoid supply are controlled from the operator console which is connected to the accelerator by a 33-foot armored cable.

With the neutron generator, Nuclear-Chicago offers (1) a sample-transfer system, (2) a variety of precision scintillation detectors, and (3) a wide choice of counting equipment.

The sample-transfer system is a pneumatically operated device which rapidly moves an irradiated sample from the target area of the generator to the sample-counting position in the scintillation detector. It can also be used to return a sample

from the detector to the target area or to introduce a new sample into the neutron flux. Sample irradiation times, sample counting times, transfer times, and delay times are controlled by the operator and are variable over wide ranges. The system allows completely unattended operation when used with the scintillation detector and counting instrumentation shown.



Typical neutron generator/counting installation. For fast-neutron activation, a "dry well" (dotted line) is immersed in the water tank, and the sample contained in the pneumatic transfer tube is suspended in air. For thermal-neutron activation, the water surrounds the pneumatic tube containing the sample.

Comprehensive specifications on the Texas Nuclear neutron generator and on Nuclear-Chicago instrumentation for use with the generator, together with descriptions of typical applications, are available upon request. In addition, if you have specific questions relating to your own need for neutron generating equipment, please refer your problem to Nuclear-Chicago. We will promptly forward complete information.



nuclear-chicago
CORPORATION

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